IN THE UNITED STATES COURT OF FEDERAL CLAIMS

Filed Electronically: September 21, 2017

IDEKER FARMS, INC., *et al.*, Plaintiffs, v. UNITED STATES OF AMERICA, Defendant.	))))))))	Case No.: 1:14-cv-00183-NBF Senior Judge Nancy B. Firestone

UNITED STATES' POST TRIAL BRIEF

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Table of Contents

Table of Authorities

Cases

Statutes

I. INTRODUCTION

The natural Missouri River was a dynamic system characterized by erosion, accretion, and avulsion. Floods were frequent. Farming in the floodplain was inherently risky. Navigation on the river was uncertain and dangerous. The United States has invested billions in dams, levees, and public works in the basin that have facilitated navigation, promoted commerce, enabled irrigation of land, and greatly reduced – but not eliminated – the effects of flooding.

The representative properties occupy *the floodplain*. Plaintiffs blame the Corps for "floods" – construed broadly to include seepage under protective levees and inefficient drainage of rainfall from protected land – that they allege have only occurred since 2004. Plaintiffs ask the Court to disregard the vagaries of nature, extreme runoff and weather, and the inherent risk of occupying a floodplain. Instead, they attribute flooding to unspecified reservoir operation changes purportedly codified in the new Missouri River Master Water Control Manual (Manual) and construction of unspecified habitat projects. The "floods" about which plaintiffs complain pale in comparison – in both frequency and severity – to flooding that would occur in the river's natural state, but for the Corps' actions. But more importantly for present purposes, Plaintiffs have failed to tie "flooding" to actions by the Corps.

Put simply, Plaintiffs have failed to meet their burden of showing a specific Government action that was the cause of each alleged taking, instead relying on a broad theory that the Corps' Manual revisions fundamentally changed reservoir operations and maintenance of the Bank Stabilization and Navigation Project (BSNP). Instead of tying specific release decisions or projects to flooding, Plaintiffs broadly assert that each event was attributable to this alleged sea change, even when nearby projects were only constructed after the floods. Plaintiffs have failed

to prove either the theory or its implied causation. Plaintiffs failed to even separate those flood claims where they allege the flooding would not have occurred but-for the complained-of changes from those where they believe the Corps operations were only a contributing factor to flooding that could not have been avoided.

Trial showed the Corps has been resolute in its commitment to reducing flood risk, while also fulfilling the other seven authorized purposes of the System. At trial, Plaintiffs (and non-party fact witnesses) provided vague and inconsistent descriptions of purported changes in the River. Plaintiffs' experts similarly provided speculative and conclusory opinions about the causes of flooding that failed to consider whether 1) there was a change at all in flooding levels as opposed to an increase in weather events and accompanying runoff that drove much of the flooding, and 2) any such changes were attributable to the Corps as opposed to other causes, such as natural variations expected in a sandbed river such as the Missouri River or made-made changes within the floodplain.

Plaintiffs' experts used unreliable methods leading them to reach conclusions not consistent with the objective data. Dr. Christensen created a subjective method not based on practice or the text of the Manual to insert his judgment about what releases would have been made under the 1979 Manual. He then compared flood stages to projections of average water surface elevations using 1990s data 2004, but his method fails to account for the wide natural variation apparent in the data before and after 2004. He wrongly assumes that any difference from the average 1990s water surface elevations is attributable to the actions alleged, even though his faulty method shows increased water surface elevations only for out-of-bank flows. Scientific publications, Corps historical documents, and stage trend data show that floodplain improvements such as relocated or heightened levees do increase water surface elevations at high

flows. Dr. Christensen failed to consider or reject these factors, or any others, as causing any deviation from average (even assuming any deviation from average reflects a trend) so his conclusion that the below-bankfull habitat projects increased water surface elevations is flawed.

Dr. Hromadka similarly assumed Corps habitat projects changed the river and flood levels simply based on a purported increase in the number of incidents of flooding as reported by plaintiffs. He opined that modest aggradation observed over many years was attributable to the Corps recent actions, but ignored a data set revealing that most of the modest aggradation occurred before 2004. He also failed to quantify how the modest aggradation, even if caused by the Corps, would affect water surface elevations. Speculative opinions like Dr. Hromadka's, based on projections of sediment additions wildly in excess of what actually happened, and relying on self-reported flood incidents by plaintiffs, are routinely rejected by courts as not persuasive expert evidence on causation. Because neither he nor Dr. Christensen compared their comparative water levels to the topography of plaintiffs' properties, they cannot even show when any incremental flooding purportedly began.

Lastly, Mr. Tofani failed to present any reliable analysis concerning the causes of levee failures and simply compared the unreliable the water surface elevations Dr. Christensen provided to levee heights. For the Middle L-575 breach, Mr. Tofani provided no analysis suggesting that the construction of the Lower Hamburg chute caused a scour hole to form. His reasoning conflicts with the industry-standard 2-D modeling from Dr. Mussetter and the Corps Engineering Research and Development Center (ERDC) showing elevated velocities of water flowing parallel to the levee, and relies exclusively on self-serving plaintiff recollections of flow directions that are contrary to the laws of physics.

In contrast, the United States' experts developed opinions based on data collected

over decades, and reliably applied that data to the questions asked. Dr. Mussetter prepared both a 1-dimensional and 2-dimensional model using industry-standard methods, tested the accuracy of his modeling by comparing it to undisputed bed elevation data, and concluded that habitat projects had little, if any, negative effect on water surface elevations during the periods of flooding and in many cases likely decreased water surface elevations. Dr. Mussetter's models accounted for both natural and human-induced variation in flow, water surface elevations and sedimentation and reliably separated effects of Corps actions from other processes.

Informed by Dr. Mussetter's conclusions, Mr. Woodbury used an industry-standard method to create an objective, repeatable model comparing releases under both Manuals and differences in water surface elevations with and without the complained-of Corps actions. Where his models indicated water surface elevations may have increased as a result of Corps activities, the increases were minor (usually inches) compared to the amount of water present regardless (usually feet). Furthermore, many of the increases predicted by Mr. Woodbury's modeling did not result from changes to the Manual predicated by fish and wildlife concerns, but instead were likely based on the Corps personnel exercising engineering judgment with respect to operation of the System, based on known conditions at the time; the same judgment that would have applied under both versions of the Manual, but could not be captured by Mr. Woodbury's rule-based model. Mr. Woodbury's transparent methodology best allows the Court to discern the real effects of alleged changes. The seepage analysis of Dr. Schaefer similarly showed that, because there were minor increases and decreases in the water surface elevations between pre- and post-2004 operations, no measurable increases in seepage occurred for leveed properties.

For federal levees, the parties dispute the cause of only the Middle L-575 breach. Dr.

Schaefer reviewed the data collected near the breach and concluded that the combination of a scour hole, an unfavorable levee alignment with a kink, inoperable relief wells the levee sponsor did not maintain, and the unprecedented flows ultimately caused the breach – not the Middle Hamburg chute or other complained-of Corps actions. This opinion is consistent with the analysis performed by the Engineering Research and Development Center and with observations after the 2011 flood of scour holes along the length of the L-575 levee both upstream and downstream of the breach resulting from high-velocity flood flows. These opinions collectively establish that the Corps actions did not cause an increase in the severity and duration of flooding.

Even if Plaintiffs' evidence were sufficient on causation, Plaintiffs have failed to meet their burden of proving that the flooding was the direct, natural, or probable result of authorized Government activity. Numerous engineers described how the Corps thoroughly analyzed potential changes from proposed Manual revisions, including detailed modeling of operational scenarios, and the selected update was estimated to have "nearly identical" flood control benefits and "comparable or less" flood damages from interior drainage and groundwater. Furthermore, after some initial analyses in the 1990s showed potential increases in interior drainage from the then-contemplated spring rise if flood-control constraints were relaxed, the actual implemented spring pulse was of much smaller volume and shorter duration, and flood-control constraints were not relaxed, because the Corps was committed to fulfilling its flood control purpose.

The Corps also performed detailed planning and design on habitat projects. For in-channel habitat, the Corps designed BSNP modifications based on observations from early modifications that did not result in increased flood elevations. For off-channel habitat, the Corps did engineering analyses including modeling that showed that chutes were likely to result in decreased levels, if any change, because of an increase in the cross-sectional area and thus

conveyance capacity of the River. During and after construction, Corps monitoring examined whether there were any changes in sediment load in the river and found no detectable change, and also examined likely seepage rates after project construction. Where structures or projects presented potential problems, they were fixed or designs updated to avoid increased flood risks to adjacent landowners. No such potential problem areas were identified in the vicinity of the representative properties. The Corps did not intend, nor did it expect, that any increased flooding would likely occur as a result of either changes to the Manual or the construction of habitat projects, and Plaintiffs have not shown that those actions did cause increased flooding.

Trial showed that Plaintiff' properties are flood-prone, with the overwhelming majority within the floodplain – and some within the designated floodway. The properties were subject to periodic flooding even after the dams were constructed when high precipitation or runoff events occurred. Furthermore, many of the properties are located on accreted land subject to increased seepage rates, and these high-flood-risk properties have not been subjected to flooding of any increased severity because of changes in river operations. Instances of flooding in successive years are common along the Missouri River, and the magnitude of flood events are not new or unprecedented, and do not reflect any change in the character of their land. Plaintiffs' cannot meet their burden to show increased severity or duration beyond the flooding that would have occurred given the extreme weather, a necessary predicate for establishing a taking.[1]

[1] With respect to any particular flood damage takings claim, the Court cannot conclude that the flooding was so severe as to effect a taking without also considering the applicable parcel-as-a-whole, for which evidence would be presented at any necessary later phase of the case.

II. FACT SECTION

1. Historic/Natural State of the Missouri River Prior to Regulation

a. History of Weather and Runoff

The Missouri River Basin has wide variations between wet and dry conditions on a seasonal, annual, and multi-year basis, and by location within the basin. DX0559-0035, DX0187-0004. "[W]et and dry cycles are apparent in hindsight, but are not [predictable] in foresight . . . ." Tr. 6869:1-19 (Farhat). Distinct periods of prolonged drought occurred during the Dust Bowl era (1930-1940s), from the mid-1950s to early 1960s, from 1987-1992, and from 2000-2007, and high runoff years occurred in between those droughts, with nine of the ten highest runoff years occurring since 1975. Tr. 6865:18-6866:10 (Farhat). Since the Master Manual revision, the basin has experienced another wet cycle. Tr. 6868:21-23 (Farhat). Since 1898, the highest runoff year on record was 2011, the 11th highest in 2010, and 2014 was much above average. Tr. 6868:15-20 (Farhat). Plains snowpack, mountain snowpack, and rainfall are the three main sources of runoff to the Missouri River, and runoff varies widely throughout the basin. Tr. 6861:12-6862:9, 6865:6-8, 14-25, 6866:13-15 (Farhat). Seventy-five percent of the annual upper basin runoff occurs between March and July, from melting snowpack that is easier to forecast than lower basin runoff, which comes primarily from intermittent, harder-to-quantify plains snowpack and rainfall. Tr. 6863:21-6864:12, 6874:16-19 (Farhat). It was not uncommon prior to 2004 for the basin to experience several flood events in short succession, such as multiple floods within one year that affected Big Lake, multiple floods in the early 1920s that affected the Kansas City District, and multiple floods within the mid-1990s in the basin. Tr. 8636:4-7 (Shumate), DX978.

2. Missouri River Mainstem Reservoir System (“System”)

a. Construction of System & Project Purposes

The Corps constructed and operates six mainstem dams on the Missouri River (collectively the “System”), for eight purposes authorized by Congress in the 1944 Flood Control Act[2] (Fort Peck in northeastern Montana; Garrison in central North Dakota; Oahe, Big Bend, and Fort Randall in South Dakota; and Gavins Point along the Nebraska and South Dakota border). Tr. 6820:6-12; 6821:1-3; 6901:20-25 (Farhat). While Congress authorized the project purposes, it left to the Corps’ discretion how best to serve those purposes through System operations. Tr. 6832:9-13(Farhat), Tr. 6458:20-6459:18 (Ponganis), Tr. 13119:12-13121:1 (Cieslik); DX0559-0115-16. The upper three dams, Fort Peck, Garrison, and Oahe, are by far the three largest Corps dams in the country based on storage capacity. The total system storage, 72.4 million acre feet (MAF), makes the Missouri River system uniquely large in terms of storage capacity, because it was designed to serve during extreme floods and extended drought periods. Tr. 6827:14-20, 6828:2-9, 6870:22-24 (Farhat). If the System was authorized solely for flood control, the design and operations would be different because, by design, these reservoirs are typically kept seventy-five percent full in order to serve all purposes in an extended drought. Tr. 6903:18-6904:15; 6905:3-12 (Farhat).

The six mainstem dams regulate only half of the Missouri River drainage basin, and cannot control runoff in the large, unregulated area below the dams, where the highest runoff originates. Tr. 6823:12-25; 6863:4-7 (Farhat). When rainfall occurs within downstream tributary watersheds or near the river downstream of the reservoirs, the Corps can adjust releases to mitigate flood risk, but it cannot recall water already released, and often cannot change

[2] The eight authorized purposes are: flood control, navigation, hydropower, irrigation, recreation, water supply, water quality, fish and wildlife. Tr. 6459:6-10 (Ponganis).

releases in time to alleviate short-term events downstream.[3] Tr. 6825:10-24; 6826:22-6827:6 (Farhat). Therefore, the Corps' ability to influence flood peaks in the lower basin depends on the timing and location of any precipitation that falls in the lower basin. Tr. 6826:17-21 (Farhat).

b. The Missouri River Master Water Control Manual ("Master Manual" or "Manual")

The Master Manual provides guidelines for operating the System under a variety of runoff conditions that can vary widely by year, month, and reach. Tr. 6869:15-19; 6880:16-17; (Farhat); Tr. 13064:4-18 (Cieslik). The Master Manual provides operators a great deal of flexibility, or operational discretion, and very few provisions are prescriptive in terms of day-to-day operations. Tr. 6880:16-23; (Farhat); Tr. 13127:6-13128:1 (Cieslik).

c. Operation of System pre-Master Manual Record of Decision ("ROD") on March 19, 2004

i. Operating Zones

The System has four primary operating zones: a permanent pool at the bottom; a carryover multiple use zone, which is the largest; the annual flood control and multiple use zone; and at the top an exclusive flood control zone. Tr. 6832:15-6834:1 (Farhat). Surcharge storage is also available; it is the space between the top of the spillway gates in the closed position and the top of the spillway gates when all are raised and releasing water underneath.[4] Tr. 6843:2-12, 6836:20-24 (Farhat). Surcharge storage is only used in extreme events, and to date has only been used at Fort Peck and Garrison dams in 1975, 1997, and 2011. Tr. 6844:23-6845:2, 4-14 (Farhat).

[3] Travel time from Gavins Point Dam to Sioux City is 1.5 days, to Omaha 3 days, to Nebraska City 3.5 days, to Rulo 4 days, to St Joseph, Missouri 4.5 days and to the mouth in St. Louis 10 days. Tr. 6824:22-6825:6 (Farhat).
[4] Each dam, depending on design, can release water from the hydropower facilities, through outlet tunnels, or through a spillway during extreme releases. Tr. 6829:18-6831:1 (Farhat). On dams that have spillways, the gates are raised and water passes underneath the gates, down the spillway structure, and past the dam. Tr. 6841:15-6842:11 (Farhat).

ii. Basic Operating Objective

By design, the annual objective is to start each runoff season with total system storage at the base of the annual flood control zone. Tr. 6905:17-21 (Farhat); Tr. 13115:3-16 (Cieslik). This provides the storage space to capture annual runoff from the plains and mountain snowpack in the annual flood control zone, and if necessary the exclusive flood control zone, and then release this water throughout the remainder of the year. Tr. 6872:16-19; 6889:9-12; 6906:1-11 (Farhat); DX0429-0113-14.[5]

iii. General Flood Control Operations

The Corps operates within the annual and exclusive flood control zones to provide flood control. Tr. 6834:18-6837:6 (Farhat); DX0429-0136. The 16.4 MAF of flood control storage was based on the 1881 design flood, the then-highest recorded. While 3.6 MAF of storage capacity has been lost due to sediment in the reservoirs, less than one percent, approximately 130,000 acre feet, was lost in the flood control zones.[6] Tr. 6837:18-24; 6848:16-6849:7 (Farhat). This is considered only a minor loss that has not impacted flood control operations. Tr. 6851:2-6852:24 (Farhat); DX0429-0075.

Flood control has the highest priority when threats to life, health, and safety issues from flood risk are present, such as during significant runoff events, but when flooding is not an issue, there are other considerations that drive the operation of the System. Tr. 6910:9-18 (Farhat); Tr. 3108:18-13112:17 (Cieslik).

[5] Paragraph 9-3 of the 1979 Master Manual states: "First, flood control will be provided for by observation of the requirement that an upper block of this intermediate storage space in each reservoir will be vacant at the beginning of each year's flood season, with evacuation scheduled in such a manner that flood conditions will not be significantly aggravated if at all possible. (This space is available for annual regulation for flood control and all multiple purpose uses, but should be vacant at the beginning of each year's flood season.)" DX0429-0113.

[6] During the 2011 maximum dam releases, this loss of 130,000 acre-feet of storage would only have accounted for less than one half a day of additional releases. Tr. 6850: 14-24 (Farhat).

iv. Upper Basin Flood Control Operations

The System is designed to capture upper basin runoff and evacuate that water prior to the next year's runoff season, using the lowest possible releases, over the longest period of time, to reduce flood risk downstream. Tr. 6914:5-24; 6918:17-6919:16 (Farhat). To accomplish this goal, the Corps calculates a Service Level to determine necessary releases throughout the year in excess of navigation flow requirements, based on projected water supply into the System. Tr. 6918: 22-6919: 16; 6921:18-6922:1 (Farhat). Plate 44 from the 1979 Manual, and Plate VI-1 from the 2004 Manual, are used to compute the Service Level. Tr. 6919:3-5; 6923:20-25; 6924:1-18 (Farhat). Plate 44 and Plate VI-I are primarily the same, except Plate VI-I was adjusted to account for sediment accumulated in the reservoirs before the Manual update. Tr. 6929:4-18; 6929:23-6930:6 (Farhat).

v. Lower Basin Flood Control Operations

Reducing lower basin flooding is the most common flood control operation, by reducing Gavins Point releases in response to runoff events below the System, while still capturing runoff from the upper basin. 6914:17-6915:11; 6931:1-5 (Farhat). Per Engineering Regulation 1110-2-240, release decisions for runoff events below the reservoir system are based on a water-on-the-ground principle, using observed streamflow at all tributary gages and observed radar-detected precipitation. Tr. 6915:16-22; 6917:3-11, 6931:6-8 (Farhat).

Gavins Point release decisions for lower basin operations are also determined by the Service Level. Tr. 6931:20-6932:2 (Farhat). The Service Level is not equal to what is released from Gavins Point. Tr. 6937:11-14 (Farhat). The Service Level is used to determine the target flows for navigation, and then releases are adjusted to meet those target flows depending on additional water from the tributaries, which can vary dramatically. Tr. 6937:11-14 (Farhat). The

Service Level is lower in times of drought and higher in high runoff years because in addition to meeting navigation targets, excess water is being evacuated from the reservoirs. Tr. 6933:10-15 (Farhat).

Navigation targets also factor in flood control constraints, a fixed increment above target flows. Tr. 6944:11-14 (Farhat). Flows are targeted at least as high as the navigation target, but to the extent feasible, below the flood control constraint. Tr. 6945:3-8 (Farhat). When feasible, releases will be reduced from Gavins Point Dam if flows in a downstream location rise above the flood control constraint, in response to that downstream runoff. Tr. 6945:9-14 (Farhat). During all but extreme runoff years, these flood control constraints are well below a flow level equating to flood stage in a given reach, so they allow for interior drainage. Tr. 6945:18-23 (Farhat). Tr. 6945:18-23 (Farhat). Despite these operational efforts, downstream flooding will still occur because of tributary flows and travel time. Tr. 6948: 21-6949:9 (Farhat). Tributary flows could alone exceed flood control constraint limits, even if releases from Gavins Point Dam were reduced to zero. Tr. 6948:21-6949:1 (Farhat). All versions of the Manual provide for reduced flows that miss navigation targets if no towboats are present. Tr. 6941:22-6943:11 (Farhat); DX0560-0168. This provision was only used since the mid-2000s, because before then, there was navigation traffic and all targets needed to be met. Tr. 6941:22-6942:5; 6944: 1-5 (Farhat).

vi. Operations for Fish and Wildlife

Fish and wildlife conservation is an authorized purpose. Tr. 6459:9-10 (Ponganis). The Corps has operated for fish and wildlife prior to and since the listing of species in the basin under the Endangered Species Act ("ESA"), prior to the 2004 Manual update, to the extent possible without significantly impacting other purposes. Tr. 6953:4-10; 6955:7-9 (Farhat).

vii. Operational Adjustments Before 2004 Master Manual Update

The Corps made operational adjustments not in the 1979 Manual, later incorporated into the 2004 Manual. Tr. 7006: 22-25; 7007:11-13 (Farhat). These included drought measures from 1988 to 1993, adjusted winter releases, and operations for the Interior Least Terns and Piping Plovers after they were listed under the ESA in the mid-1980s. Tr. 6882:15-6883:11 (Farhat).

viii. Operations for Threatened & Endangered Birds

Since 1986, to the extent feasible, the Corps has modified its operations to avoid inundating nests during the listed bird nesting season from early May until mid-August. Tr. 6956:15-6957:9; 6958:4-14 (Farhat). The Corps does not store additional water in the reservoirs to execute these operations, but modifies releases during that period to respond to bird habitat needs and the hydrologic conditions. Tr. 6959:11-16 (Farhat). The Corps has used three different flow regimes from Gavins Point dam for the birds. Tr. 6960: 20-6961:2 (Farhat); DX0560-0161; DX0560-0235. Before the birds were listed, the Corps used a Flow-to-Target operation, where releases at Gavins Point Dam were set to ensure navigation targets were being met. Tr. 6963:8-24 (Farhat). After the birds were listed, the Corps implemented a Steady Release operation, estimating in early May the highest releases necessary for navigation targets all summer, then setting that release and maintaining it through nesting season. Tr. 6964:24-6965:5 (Farhat). This operation provided additional flow for navigation, but also increased downstream flood risk because more water was being released. Tr. 6965: 6-11 (Farhat).

ix. Challenges to Reservoir Operations

Reservoir levels and releases, and benefits accruing to each authorized purpose in any year, are ultimately driven by annual runoff. Tr. 6994:13-17; 6998:4-11 (Farhat). This includes the total runoff volume, the timing and distribution of that runoff, as well as its form. Tr. 6994:18-6995:25 (Farhat). In addition, changes on the ground since the System was designed

and constructed, such as infrastructure development near and between System reservoirs, has impacted operations. Tr. 6998:23-6999:3 (Farhat). These factors are operational challenges that limit the Corps' ability to operate the reservoirs as they were originally designed.

3. Bank Stabilization and Navigation Project ("BSNP")

a. Construction of BSNP

As Chief of the Hydrologic Engineering Branch of the Omaha District John Remus testified, the BSNP was designed to create a stable navigation channel using structures to decrease river meander and maintain a self-scouring depth. Stips of Fact ¶ 4, ECF No. 187; Tr. 7956:1-4, 7994:5-16, 7996:18-23 (Remus). The BSNP is nine-feet deep with a minimum width of 300 feet, extending from Sioux City to the mouth of the Missouri River.[7] Tr. 7973:9-19 (Remus). In carrying out authorized responsibilities under the BSNP, the Corps does not seek to prevent streambank erosion unless the erosion threatens the project structures. Tr. 7976:10-16, 7980:12-13, 7981:21-25-7982:1-3 (Remus).

Before construction of the BSNP, the Missouri was a shallow, often braided river with no single, distinct river channel. Stips of Fact ¶ 1, ECF No. 187. The river carried an enormous sediment load, and the main channel was prone to significant lateral migration during high-flow periods. Tr. 8037:16-8038:20 (Remus), DX1142-0008 to 0009. The BSNP installed long dikes to constrict the channel, along with revetments and various other structures designed to maintain a reliable navigation channel. Tr. 7982:14-7983:23 (Remus), DX3004-17, DX3004-19, DX0420-0023.

The presence and operation of the System and the BSNP resulted in changes to the

[7] There are bank stabilization structures upstream of Gavins Point undertaken under the Kensler's Bend Project, and elsewhere in North Dakota and South Dakota. Tr. 8169:17-20 (Remus). Plaintiffs do not allege any flooding regarding stabilization structures upstream of Gavins Point. Tr. 8151:9-14 (Plaintiffs' counsel).

streambed and geometry of the river channel. Tr. 9549:17-25 (Bitner); Tr. 9908:3-13 (Mussetter). The reservoirs trap inflowing sediment, so less sediment is transported downstream, leading to a greater capacity to carry sediment. *Id.*, Tr. 9550:2-7 (Bitner), 8037:16-8038:20 (Remus). The BSNP creates a single-thread, self-scouring channel that provides increased sediment carrying capacity. Tr. 9549:17-9550:7 (Bitner). Thus, following completion of the dams and BSNP, the River has a much greater capacity to carry sediment and the amount of sediment in the river was greatly reduced. *Id.*

b. Operation and Maintenance of BSNP Prior to 2004 Master Manual ROD

The BSNP was completed in 1981 and has been maintained since that time by the Corps. Tr. 8990:13-15 (Chapman). Both districts use the construction reference plane (CRP), a hypothetical sloping water surface elevation, to track the elevation of BSNP structures for maintenance.[8] Tr. 8999:14-17 (Chapman). While the definition of CRP has remained constant since 1973, the level changes as the river aggrades or degrades. Tr. 8994:5-6, 19-24 (Chapman).

Both the Omaha and Kansas City District maintained structures to the same height relative to the CRP, and followed the same maintenance practices for decades. Tr. 9215:1-6, 9222:19-23 (Pridal), Tr. 8989:18-21, 9003:11-14 (Chapman). In 1973, the Corps published Structure Design Criteria specifying the height relative to CRP to which BSNP structures would be maintained. Tr. 9005:9-21 (Chapman). The Structure Design Criteria generally reduced structure heights to minimize adverse effects of the structures on flood stages and to decrease adverse environmental effects by slowing or halting sediment accretion. Tr. 9004:16-9005:7 (Chapman), DX0420-0018. The 1994 Design Criteria provided for the same relative structure heights as the 1973 Structure Design Criteria. Tr. 9004:13-14, 9012:14-21, 9017:8-11

[8] The CRP is defined based on a flow exceeded 75% of the time during the navigation season. Tr. 8992:23-25-8993:1-3, 8993:11-14 (Chapman).

(Chapman); DX0419. The Districts complete annual inspections of BSNP structures and compile a prioritized list of structures needing modification or repair. Tr. 9019:1-21 (Chapman); Tr. 9212:13-16, 9222:23-9223:1 (Pridal).

4. Impact of System and BSNP on Historic/Natural River and on River's Flood Patterns

a. Flood History and Trends

The Missouri River has long flooded frequently. Prior to dam construction, flooding was common and widespread. Major floods occurred in 1844, 1881, 1903, 1908, 1927, 1943, 1944, 1947, 1951, 1952, and 1960. DX0559-0185 to 0192, Tr. 6831:11-13 (Farhat), Tr. 7399:15-19 (Farhat), Tr. 8802:11-8804:5 (Shumate), DX1171-0019 to 0020. Between 1967, dam closure, and 2004, major flooding along the river, especially between Fort Peck and the Platte River (RM 595), was significantly reduced, but the mainstem reservoir system did not create a flood-free zone. DX0559-0038; Tr. 13112:9-3 (Cieslik); Tr. 7416:1-4 (Farhat); DX3014-81.

Even after construction of the mainstem dams, the areas below the Platte River have been especially prone to flooding as a result of flood runoff from major storms over the tributary areas below the mainstem reservoir system. DX0559-0038, Tr. 8078:3-8 (Remus). Downstream flooding occurs even if releases from the dams are reduced to a minimum because of the large unregulated area downstream of the dams, if significant rains fall. DX0559-0152, Tr. 6823:7-10 (Farhat). Major flooding occurred in 1967, 1975, 1978, 1984, 1986, 1987, 1993, 1995, 1996, 1997, and 1999. Tr. 7400:9-7415:20 (Farhat), DX559-0192 to 0200. Flooding at representative properties occurred during these years. *See* Tables 3-7 at Column H.

Besides the major floods listed above, localized flood events have also caused flooding, such as in 1969, 1973, 1979, and 1983. Tr. 8047:18-8052:20 (Remus) (describing 1969 flood

in Sioux City); Tr. 1509:14-17 (Sargent) (describing 1969 flooding); Tr. 2937:7-17; 2947:15-24 (Green) (same); 8629:20-8645:4 (Shumate) (describing 1973 flood between Holt County, Missouri and Kansas City), 2948:12-21 (Green); 3913:3-3914:14 (Frakes); DX3005-36; 3684:12-16 (Hildebrandt, P.) (describing flooding in 1979); 1040:16-25 (Sieck) (describing high water near his property in 1983 that caused interior drainage or seepage flooding).

Flooding often occurs in cyclical patterns. Tr. 6869:3-9 (Farhat). Multiple floods occurred in the mid-1980s, and the mid to late 1990s, with major flooding occurring in five of the seven years between 1993 and 1999. *See* discussion *supra*. After the major 1993 flood, an interagency committee predicted that similar floods would recur: "In some areas it represented an unusual event; in most others, however, it was just another of the many that have been seen before and will be seen again." DX0465-0009, Tr. 6361:6-6364:20 (Durham-Aguilera).

b. Sedimentation Trends

Once the dams were constructed, the reservoirs trapped sediment and the sediment supply in the Missouri River decreased drastically. Tr. 9555:12-9556:2 (Bitner), 8039:16-8040:16 (Remus), DX262-0004. The BSNP also removed sediment from the river by trapping it through accretion around revetments and notches. The post-dam lower Missouri is often referred to as sediment- starved because of the reduced sediment load. Tr. 9549:10-16 (Bitner); *see also* DX 1142 (indicating a drop in suspended sediment load at Omaha). Rates of these sediment reductions have varied. Tr. 9548:8-19 (Bitner); DX0226-0060. Because the amount of sediment carried by the river is reduced, the river has a greater capacity to transport sediment. Tr. 9549:10-9550:7 (Bitner). The lack of sediment now carried by the river has caused bed degradation, which causes problems with water supply, interferes with structure maintenance, and complicates channel maintenance. Tr. 9550:8-9551:13 (Bitner).

Sedimentation loads and bed elevations also vary based on weather, tributary loads, and flow rates. Tr. 9943:7-25 (Mussetter). During low-flow or drought periods, the channel tends to aggrade, whereas during high-flow periods, the channel degrades. Tr. 9956:6-11 (Mussetter), Tr. 8029:5-10 (Remus). For example, the 1930s drought caused channel aggradation negatively affected channel capacity. Tr. 8029:2-22 (Remus), DX353-0374. Sedimentation loads also vary based on tributary loads and other factors. Immediately downstream of the reservoirs,[9] there has been significant lowering of the channel bed, which is termed degradation or downcutting. Tr. 9209:23-9210:4 (Pridal); 8143:13-8144:11 (Remus); 9783:5-8, 9842:1-11 (Bitner). This lowering of the channel continues through at least Omaha, below which the river is in sediment transport balance—meaning the bed is neither degrading nor aggrading. Tr. 9939:21-9940:4, 9945:24-9946:18 (Sioux City) (Mussetter). The magnitude of the downcutting diminishes with distance downstream from the dams as there is more sediment input from tributaries and other sources. Tr. 9939:25-9940:4 (Mussetter).

Despite an overall degradational trend since dam closure, the bed of the Missouri fluctuates greatly due to natural processes and many locations show increases and decreases in the channel bed depending on various factors including flow rate. Tr. 9899:1-9900:20 (Mussetter). Similarly, the rate of degradation or aggradation in a reach varies due to weather, flows, and sediment loads from tributaries.

c. Post-2004 Bed Elevation Trends

The trend in declining sediment load continued after 2004. Tr. 9538:16-17 (Bitner). As

[9] The trend has been observed downstream of Garrison in North Dakota (RM 1390), Ft. Randall in South Dakota (RM 880), Gavins Point in South Dakota (RM 811). DX403-0024, 0028, 0030, 0031; Tr. 8143:13-8144:15, 8188:15-22 (Remus). Degredational trends have also been observed at gages further downstream at Sioux City (~20ft. decline), Omaha, and Kansas City (~11ft. decline). DX403-0032, 0033, and 0038. Tr. 8189:3-12 (Remus) Tr.9100:10-18 (Chapman).

MRRP projects were constructed, the Corps continued to track sediment and observed no adverse effects on sediment load because the inputs from MRRP projects are low compared to historical and present loads, and the overall sediment transport capacity of the river. Tr. 9538:8-17 (Bitner). Chance Bitner prepared two memoranda summarizing measured sediment loads and literature regarding Missouri River sediments, which he then compared to both actual and hypothetical MRRP projects to evaluate any potential effects. Tr. 9541:16-9542:24 (Bitner), DX222, DX226, DX235, DX261, DX262. The Corps' comparisons found that pre-dam suspended sediment loads averaged more than 300 million tons per year, post-dam loads averaged only between 40 and 90 million tons per year. DX 262 at 7, Fig. A, 10, Fig. A; DX 261 at 10. Actual sediment contribution from shallow water habitats (both construction and subsequent erosion) averaged 3.1 percent of the observed sediment loads from 1993-2012 (DX235) at Herman, Missouri, equating to 2 million tons per year, with a maximum annual amount estimated in 2009 at 5 million tons.[10] Tr. 9544:10-22, 9546:25-9548:3 (Bitner); DX 261-0015. Actual sediment discharges are also well below pre-construction hypothetical upper-bound estimated average sediment figures, because far fewer projects were built than the estimated upper-bound, the MRRP timeline increased, and improved accounting of existing habitat meant that less shallow water habitat had to be mechanically constructed.[11] Tr. 9547:10,

[10] Corps and USGS personnel also estimated the hypothetical upper bound of sediment contributions if all shallow water habitat contemplated in 2004 had been constructed, including the 400-mile stretch downstream of plaintiff properties. Tr. 9552:24-9554:20, 9557:17-24 (Bitner). That estimated value of 40 million tons per year was published in a 2009 paper jointly authored by Bitner and Dr. Robert Jacobson of the United States Geologic Survey. Tr. 9546:13-24 (Bitner), DX262, PX36. They used an extreme scenario of sediment loading to evaluate implications of river restoration. *See* Tr. 2149:8-15 (Jacobson) (stating that the projections of sediment were prospective estimates and referring to assumptions described in the article). *See* PX36, DX262 at 9 (stating that assumptions were unrealistic and based on assumptions of sediment-loading rates that were extrapolated from plans that existed in 2009).

[11] The 2011 flood created new shallow water habitat areas naturally. Tr. 9342:10-12 (Pridal).

9551:18-9552:6, 9558:7-9559:13 (Bitner), DX352, DX3013-65; Tr.9183:25-9186:1 (Chapman). A USGS study similarly concluded that "chutes are not a significant sediment source during normal flows and are not significantly impacting main channel sediment transport" in determining appropriate methods of sediment disposal for SWH constructions projects. Tr. 9337:3-18 (Pridal) Tr. 9580:5-13, 5962:5-10 (Bitner); DX 366.

Mean bed elevations continued to vary after 2004 based on high or low flows in the river, and depending on distance from reservoirs. In the areas immediately downstream of the reservoirs, the channel bed continued to lower after 2004, particularly during the 2011 event. Tr. 9209:23-9210:4 (Pridal); Tr. 8143:13-8144:11 (Remus), DX1070-0024 (Bismarck), DX1070-0029 (Gavins Point). At the Sioux City gage, during the dry years from 2000 through 2009, the mean bed elevations showed no significant trend or were slightly aggradational. Tr. 9946:11-24 (Mussetter), DX3014-30, DX3014-31, DX3014-54. During the 2010 and 2011 high flow years, there were several feet of degradation, and a small rebound thereafter. *Id.*

At the Omaha gage (RM 615.9), during the relatively dry years in the early 2000s, the mean bed elevations were mildly, but not significantly, aggradational. Tr. 9951:15-19 (Mussetter). The 2010 and 2011 high flows resulted in the mean bed elevation dropping by approximately 3 feet. Tr. 9951:15-23 (Mussetter); DX1034 at 3-1. Since 2011, the bed has aggraded by 2 to 3 feet. Tr. 9951:15-25 (Mussetter), DX3014-37, DX1034 at 3-1.

Finally, at the Rulo gauge, following a period during low flow years from 1998 to 2006, there was no change from 1998 to approximately 2003, which was followed by slight degradation between 2004 and 2007, followed by slight aggradation beginning in 2007 and continuing to 2009.[12] Tr. 9955:21-9956:25 (Mussetter). Similar to the upstream gauges, the

[12] In 2007, the lower Missouri River experienced a flood that originated from tributaries below

mean bed elevation lowered by about a foot during the 2010 and 2011 high flow periods, which was followed by a period of slight aggradation between 2011 and 2014. *Id.*, DX3014-43.

Between the gages, the reach from Decatur Bend (RM 690) to the Little Nemaha River (RM 527) showed no net change or slight degradation from 1998 to 2006, with spikes of aggradation near Plattsmouth Bend south of the Platte River (RM 595). Tr. 9966:13-24 (Mussetter), DX3014-54. In the reach downstream of the Tarkio River (RM 507), the trend was slightly aggradational by about one foot on average. Tr. 9966:25-9967:5 (Mussetter). As with the trend at gages, the bed elevations also declined between gages during the 2011 flood, with some areas showing a net increase from 1998 to 2012. Tr. 9967:18-9968:1 (Mussetter).

d. Stage Trend Basics and History

Stage trends, the river water elevation corresponding to a given flow over time, can depend on many factors. In addition to bed elevation, these factors include BSNP structures, accretion in the floodplain, and improvements such as road, levees, and other structures within the floodplain. In order to quantify the water level for a given discharge, scientists create stage-discharge curves, or rating curves, that are updated over time. Tr.9916:14-9917:2, 9917:12-19, 9922:7-11 (Mussetter). Rating curves, and the associated stage-discharge relationship are continuously changing due to natural processes in an alluvial river. Tr. 8028:2-8029:1 (Remus), DX353 at USACE8372071. USGS creates rating curves by applying a best-fit line through the data; although the curve approximates "average" there are data points at varying distances both above and below the curve. Tr.9917:12-9919:11 (Mussetter). Because of this variability, it is important to assess various data sources to identify and determine the cause of any trend apparent. Tr. 9110:1-9112:14 (Chapman); Tr. 10300:5-

Gavins Point. Tr. 9956:12-25 (Mussetter). This increase in bed elevation from 2007 to 2009 is likely a result of the inflowing sediment from tributaries during the 2007 flood. *Id.*

10304:8, 10337:6-8 (Mussetter).

Bed elevation can affect stages. The Corps tracks bed elevation various ways, such as by comparing stage trends and based on hydrographic surveys.[13] Tr. 8143:13-8144:11 (Remus); 9086:8-9087:5 (Chapman). In addition, the USGS publishes records containing sediment transport measurements. Tr. 9896:8-11 (Mussetter). When using water surface data to track bed elevation trends, the Corps uses data only from stages corresponding with low flows (20,000 to 40,000 cfs).[14] Tr. 9096:20-9097:25, 9099:13-17 (Chapman). It does so because stages correlating with high flows are affected by factors other than bed elevation such as overbank accretion, vegetation, or levee construction. Tr. 9098:1-4 (Chapman).

Higher BSNP structures cause more accretion and higher stages. After the 1952 flood, the Corps studied whether the BSNP was affecting water levels. Tr. 8024:1-2, 8025:6-9 (Remus); DX0353; Tr. 8033:22-25-8034:1-2 (Remus), 9010:10-16 (Chapman), DX417 at 3. The Corps determined that, for flows near channel (or bank-full) capacity, the BSNP construction had increased water stages by up to two feet from Omaha to the mouth, and approximately one foot above Omaha in the channelized portion of the river. Tr. 8026:20-25-8027:1-11 (Remus); DX0353 at USACE8372070. This is attributable to accretion within the floodplain. Tr. 8024:11-8026:12 (Remus). The Corps also determined that other floodplain infrastructure, such as roads and railroad embankments, affected increased stages than those from BSNP accretion.[15] Tr. 8027:14-25-8028:1 (Remus); DX0353. This infrastructure

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[13] Dr. Mussetter also used two principal data sources to determine short and long-term trends – USGS gage data and periodic bathymetric surveys taken at 5 to 10-year intervals that directly measure bed elevation, and can show trends between gages. Tr. 9937:14-9938:22 (Mussetter).

[14] Dr. Mussetter also exclusively used discharges below 40,000 when using stage data to evaluate trends in bed elevation. Tr. 9940:25-9941:5 (Mussetter), DX3014-24.

[15] The Corps noted also that the effect of BSNP structures on flood heights would be reduced when flows are above bankfull, and would be overshadowed by greater effects of levee

negatively impacts the river's ability to pass floodwaters. Tr. 8029:11-22 (Remus).

Levees can also affect stage trends, in that as levee heights increase, the water level at above-bank flows increases. Tr.8624:13-8625:7 (Shumate); Tr. 12479:1-21 (Schaefer). This means that if levees are high and strong enough to withstand a flood and do not fail, the stage of a given flood will be higher than the stage if those levees fail. Tr. 8029:23-8032:9 (Remus), DX353 at 8372071-8372072. As the Kansas City District has extensively documented, the number and alignment of levees can also affect stages, so that a levee of the same height moved closer to the river will further confine the floodway so that water will be higher for the same flow. *See* discussion *infra* § A.14.e. As the Omaha District found when evaluating levee capacity in the 1980s, the amount of sediment accreting or deposited between levees can also affect flood-carrying capacities so that levees originally designed to pass a given flow can no longer pass that same flow (or do so at a higher stage). *See* discussion *infra* § 14.d.

e. Stage Trend Data

Before and after 2004, water surface elevation (stage) trends for low flows tended to track bed elevation trends. Tr. 9940:5-19 (Mussetter). None of the Missouri River gages had significant stage increases at low or moderate flows since 2004, compared with previous periods. For high flows, the Rulo gage reflected continuous increases in stages since the 1950s that continued through the late 2000s. These trends are described below in more detail.

In Region One, stage trends downstream of the dams have decreased at various rates since dam closure because of channel degradation described above. Tr. 8143:13-8144:15, 8188:15-17 (Remus), DX403-0024, -0026, -0028, and -0030. At Bismarck (RM 1314.5), water surface elevations were constant to slightly aggradational since dam closure, with a

confinement, other valley changes, and private levees. *See* DX1207-0016 to -0017.

slight aggradational trend in the last 30 years. Tr. 8144:16-8145:15 (Remus). There are no changes in trends in the Bismarck or Pierre, South Dakota area since 2004. Tr. 8164:5-6, 8168:2-12 (Remus), DX403-0046, DX3004-167. At Bismarck, there were no flows above 100,000 cfs since dam closure until the 2011 flood. Tr. 8145:1-20 (Remus), DX403-0046.

At Sioux City (RM 732.2), the water surface trends are degrading, with less steep degradation between in the 1950s, 1980s through early 1990s, and 2000s; the last two periods of lesser degradation correspond with drought periods in the Basin. Tr. 8189:3-8190:13, 8190:23-24 (Remus), 9947:7-13, 9948:8-12, 9949:16-23 (Mussetter), DX403-0032, DX3014-32. At Omaha (RM 615.9), stages for lower flows increased a small amount from the 1960s to late 1990s, and from then until 2011, there was no significant trend. Tr. 9952:10-20 (Mussetter), DX3014-39. For higher flows (90 to 110,000 cfs), there has been an increase in stage since the 1960s, but stages around 2010 and 2011 are lower than those in 1993. Tr. 9953:16-9954:4 (Mussetter), DX3014-39. For the highest flows (above 125,000 cfs), there are no data points from 1952 to 2011, so though the 2011 stage is higher, one cannot discern what trend if any, there was during that 60-year period, nor after 2004. Tr. 9953:1-15 (Mussetter), DX3014-39, DX3014-40.

At Rulo (RM498), stages for low flows had no trend from the early 1950s through 2002, then there was a decrease from 2010 to the present. Tr. 9957:8-13, 9958:5-16 (Mussetter), DX3014-45, DX3014-46. At high flows (approximately 150,000 cfs) above bank full levels, the stages increased continuously from the 1950s through 2011. Tr. 9957:14-9958:4 (Mussetter). Near the St. Joseph gage (RM 448.2), stage trends at low flows have been decreasing since 1960, and at Kansas City (RM366) since 1940. Tr. 9099:13-23, 9100:10-17 (Chapman). There are no data points between 2002 and 2006 for flows at 70,000 cfs or above

because the water did not get that high during those drought years. Tr. 9100:1-7 (Chapman).

f. <u>Erosion Trends</u>

Erosion has always occurred along the Missouri River, both before and after construction of the mainstem reservoir system and BSNP. Tr. 7974:17-7982:3 (Remus). While the BSNP has helped reduce the amount of erosion, it has not eliminated all erosion, nor was it designed to do so. Tr. 7975:24-25 (Remus). Instead, the BSNP was intended to arrest the lateral migration of the banks, in order to provide a consistent and reliable navigation channel, which does not mean zero erosion.[16] Tr. 7973:9-12, 7975:7-117, 7975:24-25 (Remus).

One common type of erosion observed historically and at present are round-outs, which are circular scallops in the river bank that occur downstream of most dikes, including dikes with and without notches, from the circulating (or eddy) current. Tr. 9028:9-17, 9030:4-7, 9031:12-15 (Chapman), DX379, DX3011-56. Corps documents written decades before the filing of the Complaint in this lawsuit document these roundouts. Tr. 9028:6-9028:23, 9030:4 (Chapman), DX379.

The Corps historically has monitored and evaluated the erosion occurring along the river. Tr. 7974:17-7982:3 (Remus), Tr. 9060:18-9062:24 (Chapman); DX 1100 at 5-1; DX372. For example, the Corps has responded to land owners' concerns over erosion of their bankline since the 1940s. Tr. 7974:17-7982:3 (Remus), DX376. Following the 2011 flood, a private engineering firm, West Consultants, evaluated bankline erosion from Sioux City, Iowa to Rulo, Nebraska from 1999 to 2011. Tr. 8097:18-20 (Remus), DX1100. West concluded that erosion

[16] In carrying out its responsibilities under the BSNP authorization, the Corps seeks to maintain the navigable channel, not to prevent streambank erosion generally. Tr. 7080:9-15 (Remus). That is because the authorized purpose of the BSNP project is navigation, not flood control or other purposes. Tr. 7976:17-20, 8107:7-18 (Remus). In other words, the Corps is not authorized under the BSNP project to expend funds and take actions to protect against erosion unless the erosion threatens BSNP structures. Tr. 7976:13-16, 7980:9-15 (Remus).

occurred before and after 2004 and that during both periods erosion occurred at higher rates during high flows. DX 1100 at ES-2; *see also* Tr. 8099:23-8100:2 (Remus). Erosion caused by the record 2011 flood was particularly prevalent. Tr. 9063:12-15 (Chapman), Tr. 8192:8-8193:23 (Remus), DX 3004-199 to 201.

In sum, bankline erosion along the river has occurred even after the completion of the BSNP, before and after 2004, and more often during periods of high flows, and the Corps monitors and tracks it.[17] Tr. 7974:17-7982:3 (Remus); DX 1100 at 5-1. In addition to bank erosion, the Corps also measures erosion on levee slopes and nearby areas to see if the erosion poses a threat to levee stability. Tr.12050:6-11 (Flere). Following the 1993 and 1997 flood events, the Corps observed erosion on the river side of many levees, including at several locations along the L-575 levee. Tr.12052:13-10254:17 (Flere).

5. Impacts on Missouri River Basin ("MRB") on Fish and Wildlife from Corps' Regulation of the River and Actions Taken Prior to ROD to Address Impacts to Fish and Wildlife.

Steve Fischer, a former program manager for the Missouri River Recovery Program (MRRP), testified about the history of the Corps' mitigation and ESA efforts in the Basin. In 1981, the Corps prepared a feasibility report that concluded as a result of the construction and operation of the BSNP, 522,000 acres of terrestrial and aquatic habitat was likely to be lost by 2003. Tr. 8877:19-8878:4 (Fischer), DX 573 at 0031. The report stated that any plan to mitigate this impact must be compatible with the authorized purposes of the BSNP and not adversely impact the flood-carrying capacity of the levees. Tr. 8885:3-10 (Fischer). The public comments in response to the Environmental Impact Statement (EIS) evaluating alternatives for

[17] The conclusion that erosion correlates to flow rate is consistent with Dr. Mussetter's and Dr. Schaefer's opinions. As discussed in Section III.20.a, Dr. Mussetter opines that while erosion has occurred at some representative plaintiff properties, the erosion does not correlate to the Corps habitat construction and instead correlates to flow levels.

the proposed mitigation plan did not mention flooding as a concern. Tr. 8888:6-8889:12 (Fischer).

In 1986 Congress authorized the BSNP Mitigation Project, allowing the Corps to mitigate for the loss of 48,100 acres of habitat loss. Tr. 8889:24-8890:1 (Fischer). The Corps received funding and began acquiring land in 1991. Tr. 8894:3-10 (Fischer) DX 358. In 1999, Congress authorized mitigation of an additional 118,650 acres. Tr. 8895:10-16, 8899:22-8900:4 (Fischer).

In a 2003 Supplemental EIS (SEIS), the Corps proposed to utilize this expanded BSNP Mitigation Project to create shallow water habitat to meet goals in the USFWS 2000 Biological Opinion. Tr. 8895:17-8896:25 (Fischer), DX355. With respect to flood control, the SEIS concluded that the preferred alternative (which was selected), would result in increased floodplain storage capacity, which would be beneficial by reducing downstream flood potential. Tr. 9535:23-9536:17 (Bitner), DX355 at 0036. For groundwater hydrology, the SEIS concluded a less than significant impact was likely, with potential for localized increase of the water table, so the Corps committed to do site-specific groundwater assessments as necessary. Tr. 9536:2-4, 9537:3-18 (Bitner), DX355-0036; -0039. Pursuant to the BSNP Mitigation Project, the Corps constructed several off-channel mitigation chutes, which are listed in the attached Table 1.

6. U.S. Fish and Wildlife Service ("FWS") Biological Opinions ("BiOp")

The Corps began modifying its reservoir operations after the Interior Least Tern and Piping Plover were listed as endangered in 1985 and 1986, and has engaged in continuous ESA consultations with FWS since, while continuing to operate for all System authorized purposes, including flood control. Tr. 6955:11-17, 6958:4-10 (Farhat); Tr. 6462:14-6463:1 (Ponganis); Tr.

13314:5-20; 13317:18-13318:6; 13335:9-13, 13344:21-25 (Thabault). Because FWS ultimately concluded that the Corps proposed actions were still likely to jeopardize the continuing existence of at least one of the listed species, these consultations led to three formal Biological Opinions (BiOp), proposing Reasonable and Prudent Alternatives (RPA) to operations. Tr. 13319:7-12; 13328:4-8; 13323:2-9 (Thabault). Any RPA must be consistent with the action agency's proposed action and cannot violate or go beyond their legal authority to implement it. Tr. 6467:16-20 (Ponganis); Tr. 13308:3-7; 13314:23-13315:16; 13328:4-20; 13344:3-9 (Thabault). Accordingly, the FWS did not propose an RPA to the Corps that eliminated the Corps' ability to provide flood control; nor did they recommend any actions intending to have the Corps flood private property. Tr. 13328:21-25; 13333:25-13334:8 (Thabault); Tr. 3292:10-17; 3296:20-3297:24; 3298:19-3299:6 (Thorson).

a. 1990 BiOp

In its October 1987 Biological Assessment (BA), the Corps' proposed action was its current operations of the System for all authorized purposes, and the Corps made clear that any operations for the benefit of the birds had to remain flexible for adjustments for downstream conditions for flood control. Tr. 6463:9-6464:18 (Ponganis); DX0517. *See also* DX0426-0051. The USFWS issued a BiOp in 1990, finding the Corps' proposed action would jeopardize the birds and provided an RPA that stated operations should avoid flooding nests. Tr. 13336:13-22 (Thabault); DX0468-0052 to -0055.

b. 2000 BiOp

In 1990, the scope of the ESA consultations expanded to include impacts of BSNP and reservoir operations on the newly-listed pallid sturgeon. Tr. 6471:12-21, 6472:15-6473:8 (Ponganis); 13341:1-7 (Thabault). The USFWS 2000 BiOp found the proposed actions were

likely to jeopardize the continued existence of all three listed species and provided a new RPA. Tr. 6476:10-16 (Ponganis); Tr. 13345:14-23 (Thabault); DX0449-0263 to -0264. In October 2001, the Corps described how it intended to implement some, but not all of the five main RPA elements. Tr. 6476:20-6477:1, 6478:10-23 (Ponganis); Tr. 13345:25-13346:2 (Thabault); DX 1000. The Corps agreed to unbalance the upper three reservoirs and adjust Ft Peck flows, when conditions permitted. Tr. 6477:4-21 (Ponganis); Tr. 13346:3-11, 13347:9-12 (Thabault). The Corps did not agree to adjust flows from Gavins Point, deferring any implementation until completion of the Master Manual revision. Tr. 6477:22-24 (Ponganis); Tr. 13347:12-15 (Thabault). The Corps agreed to continue mechanically creating emergent sandbar and shallow water habitat as funding allowed. Tr. 6477:25-6478:4 (Ponganis); Tr. 13347:16-21 (Thabault). Finally, the Corps agreed to implement an Adaptive Management Plan. Tr. 6478:5-9 (Ponganis); Tr. 13346:12-13347:8 (Thabault).

c. 2003 Amended BiOp

The Corps re-initiated consultation in 2003 because new information and the Master Manual update analysis indicated Gavins Point flows described in the 2000 BiOp were outside its authority. Tr. 6480:1-14 (Ponganis); Tr. 13349:16-13350:5 (Thabault); DX0452-0007 to -0010. The Corps proposed to implement habitat creation and Adaptive Management, but not the spring pulse or low summer flows, because of concerns that the low summer flows would interfere with their ability to provide flows for navigation, an authorized project purpose. Tr. 6480:15-24, 6481:22-25 (Ponganis); DX0452-0007 to 0010.

The USFWS issued an Amended BiOp in 2003, finding that the Corps' proposed action avoided jeopardizing the birds, but that it still jeopardized the continued existence of the pallid sturgeon. Tr. 6484:3-14 (Ponganis); Tr. 13351:4-13352:6 (Thabault). USFWS proposed two

modifications for the sturgeon: 1) low summer flows until mechanical creation of 1,200 acres of shallow water habitat was completed; and 2) implementation of a bi-modal spring pulse. Tr. 6484:19-6485:11 (Ponganis); Tr. 13354:7-13355:18 (Thabault).

7. Multi-District Court Litigation

The Corps' operation of the Missouri River mainstem reservoir system for its authorized purposes was the subject of seven lawsuits in the early 2000s. Generally, the lawsuits arose from recurring conflict between upstream and downstream water-use interests, and from impacts of the System to protected species, while the Corps was revising its Master Manual to serve all interests consistent with its statutory authorities. *In re Operation of Mo. River Sys. Litig.*, 421 F.3d 618, 624-25, 629-30 (8th Cir. 2005). These competing interests and concurrent lawsuits led to potentially conflicting injunctions from district courts in North Dakota, South Dakota, Nebraska (upheld by the Eighth Circuit), and the District of Columbia, compelling or precluding specific operational decisions. *See South Dakota v. Ubbelohde*, 330 F.3d 1014, 1019 (8th Cir. 2003), *cert. denied sub nom. North Dakota v. Ubbelohde*, 541 U.S. 987 (2004); *Am. Rivers v. U.S. Army Corps of Eng'rs*, 271 F. Supp. 2d 230, 262 (D.D.C. 2003). In August 2003, noting common questions and the potential for conflicting injunctions, the Judicial Panel on Multidistrict Litigation issued an order centralizing six of the seven pending lawsuits in the District of Minnesota. *In re Operation of Mo. River Sys. Litig.*, 277 F. Supp. 2d 1378, 1379 (J.P.M.L. 2003).

Following consolidation, the district court issued an order compelling the Corps to issue an updated Master Manual by March 19, 2004. *In re Operation of Mo. River Sys. Litig.*, 305 F. Supp. 2d 1096, 1099, 1100 (D. Minn. 2004). The district court upheld the updated Master Manual and Biological Opinion, and the Eighth Circuit affirmed, except with respect to three

claims based on a flow measure that had not yet been implemented. *In re Operation of Mo. River Sys. Litig.*, 363 F. Supp. 2d 1145, 1175 (D. Minn. 2004), *aff'd in part, vacated in part*, 421 F.3d 618; *In re Operation of Mo. River Sys. Litig.*, 421 F.3d at 638. The Eighth Circuit found, *inter alia*, that Congress determined the purposes of the System when it authorized its construction in the Flood Control Act of 1944, that the Corps lacks the authority to abandon a Congressionally authorized purpose (and had not done so with respect to navigation or flood control), and that the Corps' balancing of the authorized purposes through its revisions to the Master Manual did not exceed its discretionary authority. 421 F.3d at 629-31 n.7-9. The Eighth Circuit specifically noted that the ESA would not apply if, in separate circumstances not present under the revised Master Manual, ESA compliance would require the Corps to abandon flood control or navigation. *Id.*

8. ROD of March 19, 2004

In 1989, in response to the first major drought in the Upper Basin since the System became operational in 1967, the Corps began studying revisions to the 1979 Manual. Tr. 13055:7-13, 20-22 (Cieslik). Upper Basin stakeholders wanted more water in the reservoirs during drought periods, and navigation interests sought to maintain downstream flows during droughts. Tr. 13057:1-13059:3 (Cieslik).

The Corps' 1994 Draft Environmental Impact Statement (DEIS) evaluated hundreds of water control alternatives, proposing varied operations and impacts to authorized purposes. Tr. 6997:6-6998:21 (Farhat); Tr. 13051:3-22; 13088:20-13089:5 (Cieslik); DX0491. Upon receiving comments from landowners about potential impacts of the then-proposed 3-month spring pulse releasing 20,000 cfs above normal, the Corps developed interior drainage and groundwater models to examine the differences between the proposed alternatives specifically

for these impacts, and also updated its flow modeling. Tr. 13066:1-15; 13078:13-13079:23; 13067:9-25; 13071:21-25; 13086:1-12 (Cieslik); PX0061, PX0062, PX0698, PX0699.

The 1998 Preliminary Revised Draft EIS contained additional analysis of proposed alternatives' likely effects on interior drainage and groundwater. Tr. 13089:20-13090:10 (Cieslik); DX0446-0171 to -0177; DX0356-0060 to -0061, 0131-0132, 0209-0210, 0281-0282, 0362-0363, 0483-0484. It included a groundwater study evaluating effects of pulse flows of varying magnitudes, and found relatively small impacts on groundwater levels. DX1288-0016 to 0039, 0056-0057. Additionally, a Revised EIS in 2001 included the 1998 Interior Drainage Study that investigated the influence of river level on interior ponding at seven levee units. DX0356-0038, 0117, 0194, 0265, 0347, 0459.

In 2004, the Final EIS for the Manual summarized the results of decades of study about potential impacts from proposed modifications. Tr. 13090:21-13091:15, 13095:18-23 (Cieslik); DX0430, DX0431. The analysis of anticipated impacts from the preferred alternative predicted that the flood control benefits were "nearly identical to the [Current Water Control Plan (CWCP)]," based on the past 100-year hydrologic record. Tr. 13099:1-13100:8 (Cieslik); DX0430-0011. With respect to interior drainage and groundwater, the EIS concluded that crop losses were likely to be "comparable to or less [than the CWCP.]" Tr. 13100:9-13101:15 (Cieslik); DX0430-0011 to -0012. The Corps' 2004 Record of Decision (ROD) then specified the alternative to be implemented in the new Manual and committed to developing a future spring pulse with basin stakeholders. Tr. 6521:3-10 (Ponganis); Tr. 13104:4-17, 13105:17-13106:1 (Cieslik); PX0114. The Corps did not consider this ROD as a fundamental shift in policies or procedures for providing flood risk reduction. Tr. 6380:7-6381:6 (Durham-Aguilera) Tr. 6520:2-12 (Ponganis); Tr. 6983:22-25; Tr. 6993:6-9 (Farhat); Tr. 13115:8-16 (Cieslik).

The 2006 Manual incorporated the agreed spring pulse, which was to be shorter in duration and of lower magnitude than the previous spring rise evaluated in the Interior Drainage study. Tr. 13068:24-13070:13; 13082:16-13084:24; 13105:17-13106:13 (Cieslik). The Corp then installed monitoring devices to measure downstream effects of the spring pulses. DX0456A, 0454A, 0455A. The Corps generally found that the spring pulses released in 2006, 2008, and 2009 caused no flooding or problems with interior drainage. DX0456A-0050 to -0051; DX0454A-0159 to -0160; DX0455A-0278 to -0279. Plaintiffs' experts agree the spring pulses did not caused any of the alleged flooding. Tr. 4916:18-21 (Christensen).

9. 2004/2006 Revisions to Master Manual

There were five primary operational changes to the water control plan between the 1979 and 2004/2006 Manuals: 1) implementing more stringent drought conservation measures; 2) adding criteria for unbalancing the upper three reservoirs; 3) changing minimum flows during non-navigation periods; 4) including adaptive management provisions; and 5) including criteria for a bi-modal spring pulse from Gavins Point Dam. Tr. 7007:15-7008:2 (Farhat). The first four were included in the 2004 revision and the spring pulse criteria was added in 2006. Tr. 7008:3-5 (Farhat).

The most significant change was the modification of drought conservation measures, designed to reduce flow support to navigation during periods of drought to retain more water in the reservoirs, with less impact to recreation and water supply. Tr. 7007:22-23, 7008:15-23 (Farhat). These measures only affect the reservoir operations when the reservoirs are drawn down in drought and have no impact once the carryover and multiple use zone refills to normal operating levels. Tr. 7008:24-7009:7 (Farhat). These new measures were instituted immediately in 2004 until the System recovered from drought in 2009 or 2010. Tr. 7009:12-17 (Farhat).

During the environmental review of potential impacts of various alternatives, there was no indication that implementing the drought conservation measures would have a negative impact on flood control operations. Tr. 7009:18-23 (Farhat).

The second change was including criteria and a plan to unbalance the upper three reservoirs at the start of each runoff season to provide better service to fisheries. Tr. 7009:25-7010:6 (Farhat). This plan for unbalancing maintained the same total amount of flood control capacity in the system, but one of the upper three reservoirs would start the runoff season high relative to the other projects, one would be equally as low, and the other at normal levels. Tr. 7010:6-21 (Farhat). Criteria for when this plan would be implemented was included in the Manual, but for a variety of reasons, unbalancing has never been implemented since 2004. Tr. 7010:23-7011:8 (Farhat)

The third change added two new provisions to alter flows during times of no navigation. Tr. 7011:10-11 (Farhat). The first provision had been implemented since the late 1980s, prior to the Manual revision, allowing higher releases from Gavins Point to accommodate water supply intakes during the winter to account for changes in the channel. Tr. 6882:23-6883:8, 7011:11-14 (Farhat). The second provision estimated summer Gavins Point release requirements for water supply and water quality during a season without navigation, due to new conservation measures, but this provision has not yet been implemented. Tr. 7011:17-7012:3 (Farhat).

The fourth change was to memorialize and formalize the already utilized concept of adaptive management in water management operations, to include potential changes for Endangered Species Act purposes. Tr. 7012:12-7013:16 (Farhat); Tr. 13128:15-13129:4 (Cieslik); DX0559, ¶ 7-14. The Corps committed in the Record of Decision, and the language in the Manual itself, to a structured and public process before any changes would be implemented,

recognizing public interest and potential impacts to various interest groups of any release changes. Tr. 6527:5-11, 6529:8-21, 6530:7-21 (Ponganis); Tr. 6900:9-6901:3, 7012:12-18 (Farhat); Tr. 13128:15-13129:21 (Cieslik); DX0557, DX0559-0167 ¶ 7-14. The Corps has not changed any water management operations through this adaptive management process since its inclusion in the 2004 and 2006 Manuals. Tr. 7013:17-7014:7 (Farhat); 10844:3-14 (Woodbury).

The fifth change was not added until the 2006 Manual update, providing criteria for a bi-modal spring pulse from Gavins Point Dam to benefit the pallid sturgeon. Tr. 7069:7-9 (Farhat). The spring pulse flow provisions ultimately incorporated involved lower flows than those in the BiOP and those proposed in the 1994 Draft EIS.[18] Importantly, the 2006 Manual did not adjust the downstream flood control constraints when implementing this pulse. Tr. 7078:5-7, 7079:11-13, 7080:2-4 (Farhat). Additional measures, such as utilization of the Quantitative Precipitation Forecast (QPF) in the daily river forecast, were also added to the 2006 Manual to increase flood risk reduction when the spring pulse would be implemented. Tr. 7079:14-7080:1 (Farhat).

10. Missouri River Recovery Program ("MRRP")

In 2005, Congress merged funding for the Corps' BSNP Mitigation Project and efforts to comply with the 2003 BiOp, and the Corps created the Missouri River Recovery Program (MRRP). Tr. 8899:1-14, 8900:8-10, 8903:22-23 (Fischer). The MRRP involves land acquisition, Shallow Water Habitat (SWH) and Emergent Sandbar Habitat (ESH) construction, and annual reporting of actions responsive to the BiOp provisions. Tr. 8905:4-21 (Fischer).

Under the MRRP, the Corps has designed and constructed ESH and three types of SWH projects: in-channel BSNP structure modification, such as a dike notches, that involve no

[18] The 2006 Manual included a peak increase of only 5,000 cfs over navigation flows for two days in March before return to normal navigation flows and in May, depending on many factors, a second pulse ranging from an additional 9,000 to 20,000 cfs for two days, depending on runoff forecast and reservoir storage conditions. Tr. 7076:4-25, 7077:6-24, 7079:3-10 (Farhat).

riverbank excavation; in-channel projects, requiring floodplain excavation such as a bank notch or revetment chute; and off-channel chutes created by excavation. Tr. 8104:20-23, 8107:23-25 (Remus); Tr. 9495:13-9496:21 (Bitner); DX352. SWH is only constructed on land acquired from willing sellers or public land. Tr. 8105:25-8106:2 (Remus). Each of the Corps' actions under the MRRP were done so as not to interfere with the Corps' authorized purposes for the river. Tr. 8902:22-8903:9 (Fischer). Some lands acquired have not undergone any construction. Tr. 8910:20-8911:11 (Fischer).

a. Project Planning and Design

Chance Bitner, the Chief of the Hydrology and Hydraulics in Kansas City, described the process of designing off-channel MRRP projects to ensure no adverse impacts on private property, including from sediment deposition, erosion, or flood stages. Tr. 9492:20-9493:5 (Bitner). Once land is acquired, the Corps determines the feasibility for constructing a habitat project at that site. Tr. 9498:5-22 (Bitner); DX3013-15. In this planning phase, the Corps identifies constraints that would include adverse impacts to the authorized purposes of flood control and navigation, as well as to adjacent infrastructure and private property.[19] Tr. 9500:5-11 (Bitner); DX0286-0008, 0026. The Corps creates plans and specifications for each site that describe the location and extent of the proposed project and subsurface, identify infrastructure and BSNP structures, specify the details of excavation and material disposal, and provide details about the control structures and other project features such as rocking or stabilization measures. Tr. 9503:9-9504:3 (Bitner). The Corps creates a design report that summarizes whether the project meets the goals and constraints, such as not interfering with the flood control purpose,

[19] The Corps also determines what type of analysis is required under the National Environmental Policy Act, then analyzes the potential environmental consequences from the project. Tr. 9498:5-24 (Bitner).

and is constructible and operationally sound. Tr. 9504:4-10 (Bitner). It designs MRRP projects consistent with Engineering Regulation standards applicable to all civil works projects, and they are reviewed by multi-disciplined engineers, an independent reviewer, and a non-local agency technical reviewer to ensure technical validity. Tr. 9504:11-9506:19 (Bitner).

The Corps also evaluated whether sediment contributed from project construction would have any negative impacts on project purposes and river sediment load. Tr. 9538:18-24, 9540:6-23 (Bitner). The Corps used measured sediment data to set an optimal flow rate for discharge of dredged material to minimize the likelihood of sediment deposition. Tr. 9233:11-9237:20 (Pridal); DX1072-0475, DX3013-61. Because water at higher flows both carries more sediment and has the capacity to carry more sediment, the Corps set a maximum sediment discharge rate based on the flow rate in the river. Tr. 9539:21-9540:5 (Bitner).

The Corps also designed and constructed thirteen ESH projects in a manner so as not to interfere with authorized purposes. Tr. 8171:4-5, 16-19 (Remus). During the planning phases in 2004 and 2009, the Corps Environmental Assessments concluded that the projects were not likely to affect flood stages or floodplain development, and would not affect the base flood elevation, because there was "no net change in the amount of sediment within the river . . . ." Tr. 8173:10-8174:20, 8175:6-8176:6 (Remus); DX1152-0067, DX1165-0080. The Corps found that the ESH would have minimal impacts on bank stabilization and overall no adverse impacts. Tr. 8174:12-8175:1 (Remus); DX1152-0067. Professional engineer John Remus agrees that the Corps' conclusion is consistent with his own expert engineering judgment and professional experience. Tr. 8175:2-5, 8176:21-24 (Remus).

b. Project Construction

The Corps provides detailed instructions to contractors regarding the construction of

habitat projects and disposition of excavated sediment, and does extensive quality control to ensure compliance. Tr. 9507:21-9508:5 (Bitner). The Corps also does supervision and administration with respect to construction projects, which includes engineer-level reviewing to make sure the project is constructed as designed. Tr. 9508:6-12 (Bitner).

For dredging of material for in-channel and off-channel projects, the Corps utilized experience it gained from the BSNP construction to create contemporary specifications designed to avoid adverse impacts. During BSNP construction as much as 7.8 million cubic yards of bed material was placed in the main channel without adverse impacts. Tr. 9508:24-9510:17 (Bitner); DX0353-0165; Tr. 9510:24-9512:2 (Bitner); DX0420-0067. From experience in the 1960s and 1970s using pilot channels to set the channel of the BSNP, the Corps learned that pilot channels could be utilized to create new river alignments. This experience was utilized in designing chutes without adverse effects. *Id.* The Corps also took into account designs and specifications from its observations of natural chute formation and construction of flow control structures, and that sediment from the chute expansion washed downstream (rather than settling in the channel) and did not adversely affect the navigation channel or flood control. Tr. 9512:11-21, 9513:14-21, 9514:8-17, 9515:1-22, 9516:9-14 (Bitner); DX3013-34, DX3013-36, DX3013-37. The Corps gained design and construction experience it used to design revetment chutes based on a downstream feature where the Corps did not observe substantial bank erosion resulting from the feature and also navigation depths in the main channel were maintained. Tr. 9517:1-22 (Bitner). From its ongoing channel reconnaissance in the area, the Corps learned that stone fill revetment areas could be utilized for channel widening with minimal bank erosion and no impacts to river bed elevations. Tr. 9517:23-9518:13 (Bitner); DX3013-38.

The Corps gained design experience for dike and bank notches from the historic notching

in the 1970s and 1980s intended to arrest channel accretion and maintain flow conveyance.[20] Tr. 9060:14-9061:14, 9038:3-9039:4 (Chapman); DX0399. In addition to the notches intending to diversify flow and maintain flow conveyance, the larger notches closer to the bank, including bank notches, were intended also to widen the top of the river and create more surface area. Tr. 9040:22-9041:2, 9049:8-21, 9050:18-24, 9052:18-9053:10 (Chapman); DX0596, DX3011-85. When a notch is cut, it increases the amount of water that can flow downstream through the cross-section of the river, where the dike previously impeded that flow. Tr. 9048:11-19, 9049:23-9050:16 (Chapman); Tr. 9251:20-9252:20, 9457:1-7 (Pridal). The Corps did not design or intend for notches to make deeper portions of the channel shallower, but instead to create new shallow water habitat where little or none previously existed. Tr. 9041:3-9 (Chapman); Tr. 9255:24-9256:5 (Pridal). Based on their professional experience designing and evaluating BSNP modifications, and their engineering judgment, neither Dan Pridal nor Mike Chapman believed that notches were likely to cause flooding or erosion to private property. Tr. 9060:14-9062:4 (Chapman); Tr. 9245:1-9246:9, 9246:25-9247:2, 9261:8-21 (Pridal).

Bank notches and revetment chutes later constructed under the MRRP were done in a similar manner to the historic projects utilizing engineering judgment and experience gained from monitoring earlier sites. Tr. 9520:25-9521:5, 9522:2-5 (Bitner); DX3013-41, DX0226-0036. The Corps varied the width and depth of the notches, as well as the distance from the bank depending on whether the notch was intended solely to diversify flows or also to erode the bank, or to prevent accretion deposits by inducing flow into the dike field to remove or prevent sediment deposition. Tr. 9044:5-9, 9044:14-18, 9046:3-9047:6 (Chapman); Tr. 9250:23-9251:9

[20] At one site with larger 1990s notches, banks eroded slower than expected and had not reached the amount of material anticipated. Tr. 9039:16-25, 9041:22-24 (Chapman). Notching elsewhere in the late 1990s adjacent to public land was also instructive; lower rates of erosion than expected were observed at these sites also. Tr. 9040:2-20, 9042:11-23 (Chapman).

(Pridal); DX0371, DX0389, DX0391. In the Kansas City District, notches placed on dikes bordering private property were smaller and farther from the bank; in the Omaha District, no notches were constructed adjacent to private property. Tr. 9060:5-17 (Chapman); Tr. 9222:14-17 (Pridal). The Corps also designed BSNP modifications accounting for the degradation it knew was occurring in the channel. Tr. 9041:25-9042:9 (Chapman). Where excavated sediment from river banks was disposed in the river by excavator, the Corps anticipated and indeed observed that the material would be there only temporarily, then wash downstream fairly quickly. Tr. 9523:4-7, 9524:7-18 (Bitner); DX3014-46, DX3014-47. Engineers from the Corps used their engineering judgment and professional experience to design, construct, and monitor BSNP structure modifications in a manner so as not to cause adverse effects to landowners, and specifically not to cause erosion on private property. Tr. 9060:14-9062:4 (Chapman); Tr. 9260:17-9261:21 (Pridal).

Off-channel chutes were typically constructed where there was a natural historic chute. Tr. 8108:2-20 (Remus). Sediment from excavation was discharged as a slurry mix to an in-channel discharge point, or was deposited on-land, such as behind a levee to enhance the stability berm. Tr. 9525:22-9526:20, 9527:25-9528:8 (Bitner); DX0226. For some projects, excavated material was placed within the ineffective flow area of the dike field creating temporary sandbars that washed away over time. Tr. 9532:2-13, 9534:9-22 (Bitner); DX3013-52, DX3013-53, DX3013-54. *See also* Tr. 9047:15-9048:9 (Chapman) (describing the dike field as an ineffective flow area). Where an off-channel chute project was in the vicinity of a levee, the design included a geotechnical seepage analysis for levee stability.[21] Tr. 12147:3-12155:6 (Flere); Tr.

[21] Mitigation features such as seepage berms were proposed in some locations to mitigate any adverse effects. Tr. 11976:19-11977:7 (Henggeler); DX0286-0037. *See also* DX0286-0036 (describing minimal potential for scour or erosion on levee during high flows post-chute).

11976:8-15 (Henggeler); DX0576-0223 (analyzing the impact of the chute on L-575 before construction). The Corps used accepted principles of engineering in designing and monitoring constructed MRRP projects and professional engineers Chance Bitner and Dan Pridal relied on their engineering expertise and judgment to conclude that flooding on private property was not an intended or expected result of the projects. Tr. 9656:14-22 (Bitner); 9245:1-9246:9 (Pridal).

When constructing emergent sandbar habitat (ESH) projects, the Corps excavated existing sand from the river and placed it elsewhere within the channel. Tr. 8171:22-8172:15, 8177:1-14 (Remus); DX3004-174, DX3004-176. The Corps had design plans and drawings calling for excavation no deeper than the thalweg (lowest elevation) so no channel changes would be expected, and did not excavate or place material within 100 feet from the bank to decrease the likelihood of erosion. Tr. 8172:16-8173:8, 8182:15-8183:8 (Remus); DX3004-185.

c. Post-construction maintenance, surveying, and repairs

The Corps continues to monitor project sites after construction and maintains and repairs them when necessary. DX1030; Tr. 9327:4-9331:20 (Pridal). Regular bed surveys and field surveys of the river structures are conducted. DX1030, DX0596, DX1047, DX0352; Tr. 9327:4-9331:20, 9338:4-17 (Pridal); Tr. 9076:11-16, 9090:18-23 (Chapman); Tr. 9573:1-9 (Bitner). The Corps monitors project performance to ensure that projects are functioning as intended, any unanticipated impacts are addressed, and to inform the design of future projects. DX1060-0004; Tr. 9246:14:23 (Pridal); Tr. 9351:4-9252:5, 9331:21-9334:17 (Pridal); Tr. 9039:16-25 (Chapman); Tr. 9504:11-19, 9634:11-16 (Bitner).

For in-channel projects, the Corps collects and analyzes hydrographic, flow and velocity, and sediment data allowing them to compare modified and control bends. DX1041, DX1045, DX1042; Tr. 9338:4-9339:16 (Pridal). These reports showed little change as a result of the dike

notching program. Tr. 9339:15-9341:4 (Pridal).

In 2013, the Kansas City District, working with the state of Missouri, solicited public input about notch performance. DX0372; Tr. 9062:6-20, 9063:17-9064:7 (Chapman). The Corps found that many landowner concerns were at locations where no notch was present, and only two locations upstream of Kansas City were identified. DX0372-0019, 0105 to -0106; Tr. 9062:20-24, 9063:9-11 (Chapman). The study concluded that the amount of erosion was essentially the same for notched and un-notched locations. DX0372-0114; Tr. 9064:9-24 (Chapman).

The Corps also continuously monitors off-channel habitat projects. Tr. 9497:2-10, 9634:7-9635:5, 9657:1-9658:21 (Bitner); DX0267. Each completed project has an operations and maintenance manual that outlines post-construction monitoring activities. Tr. 9075:23-9076:5 (Chapman). Projects are optimized by utilizing a "structured approach for learning from design and monitoring efforts . . . ." Tr. 9265:5-9 (Pridal). In fact, the lessons learned during the monitoring and evaluation phase of one project were often incorporated into the design and construction of future projects. Tr. 9506:21-9507:16 (Bitner).

The Omaha district prepared reports assessing off channel habitat projects in 2009 and 2011. Tr. 9350:10-9351:14 (Pridal); DX1060, DX1039. The 2009 report evaluating velocity and flow concluded that all chutes except one "were performing fairly closely to the desired range." Tr. 9351:20-9352:2 (Pridal); DX1060. The entrance control structure on the errant chute was repaired in 2010. DX1060; Tr. 9352:2-4 (Pridal). The post-2011 report indicated that the flood had damaged projects and recommend corrective repair actions. DX1039; Tr. 9352:21-25 (Pridal). The Kansas City district similarly conducts monitoring, both routine and in response to landowner concerns. DX0277; Tr. 9591:11-9592:6 (Bitner). One such study found no increased

erosion risk to levees or private property. DX0259; Tr. 9619:6-7 (Bitner). Studies by other agencies have also informed project planning regarding sediment[22]. Tr. 9577:23-9580:13 (Bitner).

d. Post-construction seepage analyses

In addition to monitoring sedimentation and chute migration, the Corps has also analyzed seepage amounts near SWH projects when necessary based on engineering judgment or at the request of the public. Tr. 11976:8-15, 11978:19-11979:14 (Henggeler); Tr. 12146:20-12147:2 (Flere). The results showed no increases in seepage near Plaintiff properties. Corps geotechnical engineer Geoffrey Henggeler compared expected seepage pre-chute, as-is, and as if no mitigation berm had been constructed at Worthwine Island. DX0363; Tr. 11976:8-15, 19-22, 11979:19-11983:1 (Henggeler). With the chute and berm extensions, seepage rates closest to the levee increased by only one percent – a result within the modeling margin of error. DX 363; Tr. 11976:9-15, 11983:12-11984-5 (Henggeler). Seepage quantities decreased with distance from the levee and underseepage was negligible beyond 1,000 feet from that levee toe.[23] DX0363; Tr.11986:2-20 (Henggeler). The Worthwine study informed expectations regarding potential increases in seepage quantities and methods to mitigate additional seepage for future projects. Tr. 11986:21-25, 11987:2-8, 11991:23-11992:10, 11994:8-24 (Henggeler).

The Omaha District also analyzed seepage at the Deroin and Nishnabotna Bend projects after those chutes migrated closer to the levees during the 2011 flood. Tr. 12146:20-12147:12 (Flere); DX0886. There, seepage quantities were consistent with design criteria and no mitigation was needed. DX0886; Tr. 12147:3-7, 14-21, 12148:8-23, 12149:22-12151:5 (Flere).

[22] *See e.g.* DX1095, DX0367, DX1069, DX1096, DX0366, DX0235, DX0236, and DX0237.
[23] The Rouse Trust property is over 2,000 feet from the levee toe, and one mile from the river. Tr. 12291:23-12292:1 (Schaefer), Tr. 3492:15-18 (Rouse).

Seepage analyses have also been conducted for proposed SWH projects in both districts. Tr. 11995:18-11996:10 (Henggeler); 12151:15-22 (Flere); DX0364, DX0881, DX0882, DX0809. Where these pre-construction analyses estimate increased seepage pressure from the proposed project, mitigation measures have been designed and constructed, or projects were modified to avoid adverse effects. DX0881, DX0882, DX0809; Tr. 12151:24-12157:17 (Flere).

e. MRRP Projects

Under the MRRP, the Corps has constructed dozens of off-channel chutes, backwaters, revetment chutes, and various in-channel shallow water habitat, in addition to the upstream emergent sandbar habitat projects. The projects constructed, including the type, location, date of construction, and proximity to adjacent levees, are listed in the attached Table 1.

The 2011 flood dramatically altered the entire floodplain and river channel, damaging and altering MRRP projects and BSNP structures both modified and unmodified. Tr. 9326:4-24, 9353:6-25, 9354:3-9 (Pridal). The Corps has since conducted extensive repairs so that projects can continue to function as designed. Tr. 9314:5-10, 9320:14-18, 9321:10-15, 9321:22-25, 9322:14-18 (Pridal). Although the chutes at the Nishnabotna Bend and Council Bend widened during the flood, and the Upper Hamburg Bend chute migrated toward the levee, the adjacent levees fairly close to the chutes (*e.g.* 250 feet) did not breach. Tr. 9313:3-19, 9314:13-14, 9321:22-25, 9322:5-7, 9322:14-18, 9323:4-6, 9319:20-25, 9368:25-9369:5 (Pridal). Other MRRP chutes and projects had sediment deposition but no excessive erosion or structure damage; others were altered, but are still performing in a satisfactory manner. Tr. 9325:23-9326:3 (Pridal).

11. Public Involvement Following 2004 Changes to Master Manual and MRRP

The Corps committed in its Record of Decision for the Master Manual EIS and in the

Master Manual itself to continue robust public involvement concerning any proposed changes to System operations. Tr. 6530:7-17 (Ponganis); DX0557; Tr. 6899:22-6901:3; 7012:12-18 (Farhat); Tr. 13128:15-13129:21 (Cieslik). The Corps solicits and considers public comments annually concerning System operations, issues monthly press releases about System operations, and maintains an extensive public website with the latest System forecast information. Tr. 6898:10-6899:2, 7-14 (Farhat); DX0557. In addition, the Missouri River Recovery Implementation Committee ("MRRIC"), proposed and convened by the Corps to incorporate public input when implementing actions to comply with the BiOp, has met quarterly since 2008 and includes representatives from all Basin States and Tribes, and 29 stakeholder interest groups. 6529:22-6530:1; 6530:23-6531:13; 6532:3-25 (Ponganis); DX0557. Public involvement also occurs pursuant to NEPA when Project Implementation Reports ("PIR") are developed for habitat sites. Tr. 8916:3-10 (Fischer); 9294:22-9295:22 (Pridal); Tr. 9501:6-9502:12 (Bitner).

12. System Changes After 2004.

The number of operating zones and the corresponding elevations did not change in the 2004 or 2006 Manual update. Tr. 6834:14-17 (Farhat); Tr. 13118:2-8 (Cieslik).

a. <u>Basic Operating Objective</u>

The basic operating principles of the System have not changed before or since 2004. Tr. 6883:18-19 (Farhat). The basic objective of annual reservoir operations is still to start each runoff season with total system storage at the base of the annual flood control zone Tr. 6905:17-21; 6983:22-25 (Farhat); Tr. 13115:3-16 (Cieslik). This did not change in the 2004 or 2006 Manual update. Tr. 13113:13-13114:5; 13114:22-13115:16; 13188:21-13189:7 (Cieslik); DX0560-0133, ¶ 7-04.6; DX0429-0113, ¶ 9-3. The Corps continues to meet this goal and evacuates all water from the flood control zones every year prior to the start of the next year's

runoff season. Tr. 6908:1-8 (Farhat).

b. General Flood Control Operations

Neither the 2004 or 2006 Manual revisions changed the designated flood control storage space or the reservoir flood control operating procedures or priorities. Tr. 6983:22-25; Tr. 6993:6-9 (Farhat). In fact, operations for flood control purposes is largely the same under the 1979 and 2004/2006 Manuals, even when factoring in considerations for the ESA-listed birds. Tr. 6991:5-6992:5 (Farhat); DX0560-0151, ¶ 7-04.29.

c. Upper Basin Flood Control Operations

The key concept in years of high runoff remains the same: releases are based on the amount of water currently stored in the reservoirs, as well as anticipated runoff for the remainder of the year. Tr. 6888:3-6889:5 (Farhat). This operation is guided by using Plate VI-I in the 2004 Manual, which replaced Plate 44 in the 1979, but remains substantially the same with just a slight adjustment for sediment. Tr. 6888:18-22; Tr. 6929:4-18; 6930:2-6 (Farhat).

d. Lower Basin Flood Control Operations

During normal to below normal years, the Service Level continued to be based on the actual system storage after the 2004/2006 Manual update. Gavins Point releases continued to be based on the need to meet navigation and winter release targets, but with the flexibility to adjust releases to respond to downstream flooding events. Tr. 6884:10-6885:16; 6887:17-21 (Farhat). Although analyzed, the flood control constraints, designed to allow reduction in flows from Gavins Point Dam in response to downstream flooding events, ultimately did not change in the update to the 2004/2006 Manual. Tr. 6945:9-14 (Farhat); Tr. 13118:9-10 (Cieslik). The basic operating principles related to Service Level, navigation targets, and flood control constraints all remained the same as in the 1979 Manual. Tr. 6946:5-13 (Farhat).

e. Operations for Threatened & Endangered Birds since 2004 Manual Revision

In 2003, the Corps shifted to a Steady-Release-Flow-to-Target operation during the bird nesting season that combines the two former methods, conserves water during drought, and reduces downstream flood risk in the spring. Tr. 6961:4-14 (Farhat). This new operation has been implemented since 2003. Tr. 6965:21-6966:3; 6966:18-19 (Farhat). Under this regime, instead of estimating the releases necessary for navigation throughout the entire summer, when the birds begin nesting in early May a steady release rate is selected that should be sufficient to last through June, but not one high enough to last through the driest part of the summer. Tr. 6966:4-10 (Farhat). Then, if conditions dry out and higher releases are necessary to meet navigation targets, the Corps reverts to a Flow to Target operation and relies on the ITS in the 2003 BiOp to afford its operations coverage for any take that may result from the increase. Tr. 6966:11-15 (Farhat). The end result is a bird operation that reduces downstream flood risk because less water is being released from Gavins Point Dam during the spring, the wettest part of the season. Tr. 6966:24-6967:7 (Farhat). Another technique employed to minimize the impact of these releases when there is downstream flooding is called "cycling," where the higher target release is for only one day, followed by two days of lower releases. This cycling technique accomplishes the goal of preventing the birds from nesting in lower portions of sandbars, but results in less total water being released downstream because of two days of lower releases. Tr. 6974:9-22 (Farhat).

Downstream flood control constraints were not adjusted and still apply the same during bird nesting season and bird operations are temporarily or completely suspended during high runoff years with downstream flooding. Tr. 6967:8-6968:12 (Farhat). Example of years when bird operations have been at least temporarily suspended as a result of high flows on the lower

river include 1993, 1995, 2008, 2010, 2011, 2013, 2014, 2015, and 2016. Tr. 6970:4-9; 6980:21-6981:8 (Farhat); DX0467, 498, 499. In years when bird operations are adjusted to account for downstream flooding concerns, the Corps coordinates with FWS who will still monitor and track any incidental take as a result of the higher flows. Tr. 6968:6-6970:1; 6981:1-8 (Farhat).

f. Implementation of Spring Pulse included in 2006 Manual

The spring pulse was implemented only in 2006, 2008, and 2009. Joint Stipulations of Fact at 11, ¶¶ 48-51. The Corps conducted monitoring for potential interior drainage and groundwater impacts during each of these three pulses, and none were detected. Tr. 7080:24-7081:1 (Farhat).

13. BSNP Changes After 2004

The Corps has maintained structures to the same height relative to the CRP, and followed the same maintenance practices, for decades. Tr. 9215:1-6, 9222:19-23 (Pridal), Tr. 8989:18-21, 9003:11-14 (Chapman). The Corps continuously inspects and monitors BSNP structures to identify deficient structures; structures needing repair are prioritized to determine which repairs are funded in a given year. Tr. 9019:10-13 (Chapman). Water surfaces are also routinely collected to periodically update the CRP. Tr. 9019:10-13 (Chapman). Only in the severely degraded reach of the river in and slightly above Kansas City has the Corps physically removed rock from structure crests, because structure heights exceeding design criteria can lead to unwanted accretion and negatively impact flow conveyance. Tr. 9026:14-9027:25 (Chapman), DX3011-55.

There are several factors that could lead landowners to erroneously conclude that structures are not being maintained or maintained to lower heights. Repairs are only made to structures that have degraded more than two feet from the design height. Tr. 9018:3-7

(Chapman). Since structure heights are relative to the CRP, the maintenance height might be lower than the existing height so no maintenance is required. Tr. 9003:5-14 (Chapman), 9214:13-20, 9215:1-6 (Pridal), Tr. 7981:21-7982:3 (Remus). Indeed, in the Kansas City District, the CRP elevation has been decreasing over time since at least 1990, which is indicative of the river bed degrading and means that structures are maintained to a lower elevation overall, while still adhering to the 1973 criteria. Tr. 9001:16-9002:10, 9003:15-21 (Chapman), DX0398, DX3011-22. Finally, the 1973 Structure Design Criteria specified lower heights than the original structure design heights regardless of changes in the elevation of the CRP. Tr. 9215:1-24 (Pridal).

14. Levee Systems and Levee Failures in Each Flood Year

There are federal, non-federal PL 84-99 levees, and private or other levees along the River.[24] Tr. 12598:20-12599:8 (Kneuvean). Federal levees are designed and constructed by the federal government, then turned over to local entities to maintain and operate pursuant to an Operation and Maintenance ("O&M") manual. Tr. 12612:10-22 (Kneuvean), 8589:4-16 (Shumate). Non-federal levees, not designed or constructed by the federal government, but maintained by a local sponsor, are typically not designed using engineering specifications nor are they constructed in a manner similar to federal levees. Tr. 12611:21-12612:8 (Kneuvean). Traditionally, non-federal levees are smaller and overtop at lower-magnitude flood events. Tr. 8619:14-8620:7 (Shumate); Tr. 12604:6-12, 12606:23-12612:3 (Kneuvean), DX0971, DX3016-14, DX0959; DX3016-15. Private levees are those constructed and owned by entities not part of the PL 84-99 program. Tr. 12603:19-24 (Kneuvean). The Corps has no authority to approve the alignment (location) or height of either non-federal PL 84-99 or

[24] Public Law 84-99, codified in 1955 as 33 U.S.C. 701n, dictates rehabilitation and repair funding for levees. Tr. 12600:10-25 (Kneuvean), DX0959.

private levees. Tr. 8590:9-15 (Shumate).

a. Federal Levee System as constructed

In 1947, after repeated inundation of private levees, the Corps proposed a plan to construct a series of levees from Sioux City to St. Louis aligned for a floodway width of 3,000 feet. Tr. 8591:3-8592:24 (Shumate), DX1197-0010-11, DX1174-0033. The Corps planned to place levees "at least 1,000 feet from the established channel line," in order to "reduce velocities adjacent to the levees, minimize the effects of local bank erosion, . . . and reduce the dangers of underseepage." DX1197-0017, ¶ 39.

The federal levees were generally constructed between 1949 and 1966, with some as recently as 1986. Tr. 12033:16-12034:14 (Flere); Tr. 8806:24-8807:14 (Shumate). The estimated level of protection for an individual levee system was based on reservoir operations, and the levee height, and setback distance. Tr. 8595:20-8596:17 (Shumate). Omaha District federal levees were originally estimated to provide between a 50-year and 500-year level of protection, and Kansas City District levees were all estimated to provide more than a 100-year level of protection.[25] Tr. 8076:5-8077:14 (Remus), Tr. 8600:23-8601:11 (Shumate), DX1162-0030, DX1204.

In the Kansas City District, many of the federal levees contemplated in the 1947 plan described above were not actually constructed. Tr. 8605:19-24 (Shumate). Between Rulo (RM 498) to Kansas City (RM 367), only 67% of what was envisioned in the Pick-Sloan plan was constructed.[26] Tr. 8606:10-17 (Shumate). In Holt County, local objections were raised to

[25] Levee Unit L-550 was estimated to offer a 50-year level of protection based on 1961 discharge records. DX1162-0030. Levee Unit L-575 was estimated to offer a 100-year level of protection based on 1961 discharge records. *Id.*

[26] In Holt County, the contemplated federal levees were not built on the left bank between approximately RM 483 and 505, nor in Buchanan County between RM 403 and RM428. Tr.

construction of the federal levee, and after a court order, it was never constructed. Tr. 8615:6-8616:7 (Shumate), DX0975.

i. Local responsibilities and inspections

Federal levees have maintenance requirements that local entities did not always follow. After construction, the Corps turns over responsibility for federal levees to the local sponsor for maintenance and operations. In 2007, the Corps established a new levee safety program involving geotechnical engineers, who serve as levee safety engineers. Tr. 12079:12-22, 12081:8-15 (Flere), DX0967-0006. The schedule calls for a detailed "periodic inspection" every 5 years that evaluates operational adequacy, structural stability, safety of the system, and compares original against current design criteria and loads, and less-involved annual "routine inspections" that verify maintenance, owner preparedness, and component operation. Tr. 12612:23-12613:5 (Kneuvean), DX0967-0007. The O&M manuals describe maintenance of drainage structures and relief wells (including performing sounding, cleanout, and pump tests), and require the sponsor document and provide maintenance records to the Corps. Tr. 12103:22-12106:6 (Flere), 2126:8-2128:20 (Woltemath), DX0896 at §§ 6.4.2, 6.5.

Levees near Plaintiff properties were not well maintained. Since 1950 at levee L-575, the Buchanan drainage district (responsible for the portion with the middle breach) has never provided documents indicating any relief well maintenance was performed. Tr. 12109:3-15, 12110:4-15 (Flere). 2008 inspection reports reported no maintenance had been completed and some relief wells were silted to the top and thus minimally acceptable; 2009 and 2010 reports rated them unacceptable. Tr. 12110:17-12117:1 (Flere), DX0838-0008, DX0837-0008,

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8608:2-8609:19, 8610:13-21 (Shumate), DX0522-0160, DX3005-24. Plaintiffs Cunningham Farms (#57), Drewes (#21/22/23), Luce (#193), Saunders (#297), Cunningham Trust (#58/59), Binder (#71/72/73/74), and Frakes (#89A) assert claims for property in the areas behind were these levees were not constructed. Tr. 8611:13-25, 8612:21-25 (Shumate), DX3005-24.

DX0614-0008, DX3017-85, DX3017-86, and DX3017-87. During the 2011 flood, levee safety program head (and geotechnical engineer) Bryan Flere observed and documented three of four wells nearest the breach not fully functioning. Tr. 12100:25-12101:23, 12117:18-12118:1, 12119:4-12, 12133:24-12134:10 (Flere), DX0883-0002, DX3017-73. Although persons attempted to pump debris from the wells to regain functionality during the flood, there is no evidence the wells were functioning at the designed rates by the time the levee failed. Tr. 12343:20-12344:18 (Schaefer), Tr. 12135:6-12136:19 (Flere), DX0849, DX0854. A flap gage and slide gate at the L-624 levee near the Adkins property were unable to close during the 2010 and 2011 floods because of a bent rod and excessive sediment, and backflow from the river flowed through the open drainage structures into the levee interior. Tr. 12090:6-12094:2 (Flere), DX876.

ii. Ponding areas

Several representative properties lie within designated ponding areas, and they and others are situated in low-lying areas near drainage ditches that collect rainwater from the interior. *See* Tables 3-7, Column O. Federal levees were designed with ponding areas where interior runoff from precipitation landward of the levees would concentrate; usually, these ponding areas are located in lower lying areas that hold water or near drains. Tr. 8082:14-8083:3 (Remus), DX0896-0021 (describing ponding areas for L-575 to hold water during flood emergencies). The manuals provide restrictions on use of ponding areas, specifying that ponding areas "for temporary storage of interior runoff during flood periods" shall not be allowed to fill with material and that the levee districts should take care "not to allow encroachment that will limit their use as ponding areas." Tr. 8083:4-8084:2 (Remus) (quoting 33 C.F.R. 208.10(h) and DX0890-0084). Ponding areas and drainage pipes are designed

based on historical storm events; typically for agricultural areas, they can collect water from a 10-year precipitation event within the catchment basin. Tr. 8087:14-22 (Remus).

b. Non-federal levee system as constructed

There have been many changes to the non-federal levees within the Kansas City District[27] over time, and the non-federal systems differ with respect to alignment, design, height over time, and stability.[28] From 1955 to 1986, the federal government paid all repair costs, and there were few maintenance or operation requirements. Tr. 12601:2-16 (Kneuvean). As of 1986, local sponsors bears some of the repair costs, and as of 1991, the Corps requires inspections. Tr. 12602:2-17 (Kneuvean). Stricter eligibility criteria and a public-sponsor requirement meant the number of non-federal PL 84-99 levees went from 800 in 1955 to 156 presently. Tr. 12601:7-9, 12602:20-12603:18 (Kneuvean). The Corps has not tracked the location, height, or condition of any levees no longer within the PL 84-99 program or private levees. Tr. 12603:19-24, 12617:4-15 (Kneuvean). Initial and continuing eligibility requirements are minimal.[29]

c. Levee Alignment

Because of variances in geography, topography, and land availability, there are areas

[27] Only one remotely-located non-federal PL 84-99 levee abuts the River in the Omaha District; the text herein pertains nearly exclusively to the Kansas City District. Tr. 12033:10-14 (Flere).
[28] Non-federal levees typically do not include a stability berm, underseepage berm, drainage pipes, relief wells, or other features designed to minimize seepage and allow drainage; non-federal levee sections do not usually have impervious fill on the riverward side to reduce seepage. Tr. 12606:23-12608:10, 12610:17-12611:6 (Kneuvean).
[29] Agricultural levees must provide a five-year level of protection. Tr. 12604:1-12605:4, 12605:15-18 (Kneuvean), DX0919-0060. The Corps does not do a detailed analysis to determine whether levees will perform. Tr. 12606:10-21, 12614:24-12615:21 (Kneuvean). The Corps does continuing eligibility inspections every two years to satisfy the safety inspection checklist and to detect significant changes that may affect levee integrity. Tr. 12605:19-12606:6, 12615:23-12616:13 (Kneuvean), DX0919-0062. No engineering assessment is required after the initial eligibility assessment when a levee system is enrolled in the PL 84-99 program. Tr. 12616:6-9 (Kneuvean).

along the River where levees have historically unfavorable alignments that can contribute to flooding. Constriction or pinch points, where the distance between levees (or the levee and the bluffs) is narrower than areas downstream, put more stress on levees. Tr. 1966:18-1967:7 (Ettleman), 12042:15-12043:21 (Flere), 8739:12-17 (Shumate) (describing how narrower levees decrease the level of protection). The levee systems also contain kink points – areas where the levee juts out toward the river then turns sharply away from the river. Tr. 12045:4-11 (Flere). At constriction and kink points, the Corps observed severe post-flood erosion, including along the L-575 levee during the 2011 and 1993 floods.[30] One such 1993 scour hole was near the breach location. Tr. 9372:18-9373:9, 9374:12-14 (Pridal), DX3012-142.

Many plaintiff properties lie in areas with constrictions or narrow floodway widths where increased flood heights, increased flow velocity, and a higher propensity for erosion are expected.[31] Tr. 8751:12-8752:21, 8756:3-19 (Shumate), DX1209. When the water is higher on the levee, the higher pressure causes increased rates of seepage. Tr. 12227:2-23 (Schaefer), DX3018-28. Some constrictions near Plaintiff properties are in Table 12.

d. Changes to system capacity, levee locations, and effect on stages

Since construction, changes in hydrology, levee capacity, locations, and stability of levees have affected performance. In 1984, the Omaha District studied the feasibility of increasing capacity in the levee system to provide a higher degree of protection because of a decrease in the level of protection. Tr. 8069:9-8074:13 (Remus); DX1162-0022 (describing how flood stages have increased as much as 3 feet attributable to channel stabilization,

[30] Tr. 12043:5-21, 12044:12-12045:3, 12048:20-12051:11, 12052:5-11, 12053:7-13 (Flere), 12625:22-12628:12, 12629:5-25 (Kneuvean), 1969:4-19 (Ettleman), DX0909, DX3017-17, 3017-20, DX3017-21, 3017-22, 3016-25, 3016-26, 3016-27, 3016-28, 3016-29.

[31] Other undocumented floodplain constrictions exist. For example, private levees restrict the floodplain width in areas north of Council Bend. Tr. 1074:9-1075:4, 1075:17-23 (Sieck).

siltation, an secondary levee construction of secondary levees). The study also found that flows for the 50-, 100-, and 500-year floods increased beyond the 1961 numbers at Rulo and Nebraska City. Tr. 8072:9-8074:8, 8075:18-24 (Remus), DX1162-0028. Below the Platte, the degree of protection provided dropped.[32] Tr. 8076:18-8077:14 (Remus), DX1162-0030.

Changing levee locations and heights can and have exacerbated existing constrictions and have been causing increasingly higher flood elevations for decades. During the 1973 flood, with flows significantly lower than peaks in the severe 1951/1952 floods, water levels at St. Joseph and Rulo were close to or higher than the 1952 levels, and as many as 3-4 feet higher than water levels for the same discharge in past years.[33] Tr. 8632:5-24, 8641:14-8642: (Shumate), DX0978. The Corps attributed 80% of the increased flood heights to private and non-federal levee construction and 15-20% to BSNP structures. Tr. 8633:1-13, 8639:10-15, 8640:1-14 (Shumate), DX0978, DX0976. The Corps told state agencies that the stage increases observed in 1973 were due to floodplain encroachment and uncontrolled and uncoordinated construction of non-federal levees, and the placement of these non-federal levees very close to the river bank, but no agreement or memorandum of understanding was finalized.[34] Tr. 8638:2, 8642:5-25 (Shumate).

Despite knowledge that future trends in the stage-discharge relationship depended on the extent of additional floodplain encroachment, the Corps had and has no ability to regulate or specify alignment of non-federal levee placements. Tr. 8643:4-8644:15 (Shumate),

[32] Though L-550 (20-year flood) and L-575 (40-year flood) protect the largest areas, they had the lowest degree of protection as of 1986. Tr. 8077:11-14 (Remus); DX1162-0031.
[33] The 1952 flood of record peaked at 358,000 cfs at Rulo. The 1973 flood peak at Rulo was 125,000 cfs. Tr. 8630:12-22, 8634:3-10 (Shumate), DX3005-36.
[34] At the time of the 1975 flood, the Corps described how 60% of non-federal levees were within the 3,000 foot floodway and 35% of the non-federal levees were within 2,000 feet. Tr. 8642:21-8643:3 (Shumate), DX0978-0002.

DX0978-0002. The Kansas City District later proposed a policy setting floodway widths to 3,000 feet and keeping non-federal levees to a 30-year flood level, but states could elect whether to enact and enforce regulations consistent with the policy. *Id.* DX1198. Although some states and counties do regulate development within the floodplain, and particularly the floodway, some do not enforce the regulations. The Holt county floodplain regulation was enacted by at least 1988, but former county clerk Kathy Holstine confirmed it is not enforced, though it recognizes that "flood losses are caused by (1) the cumulative effect of development in any delineated floodplain causing increases in flood heights and velocities . . . ." DX0152 at § B.2. Tr. 4388:11-4390:15 (Holstine).

Since 1973, the Corps the upward trend in flood stages attributable to changes in levees continued. *See e.g.* DX1207-0016 (noting that increased flood stages (at lower flow rates than earlier floods) in 1978 at Nebraska City and St. Joseph were "aggravated by increased utilization of low-lying floodplain areas that [have] caused a reduction in overbank capacity.") Tr. 8658:17-8659:2 (Shumate). The 1981 post-flood report documented upward stage trends at high discharges above 100,000 cfs at all gages except Kansas City and Sioux City, and that private levee construction had decreased floodplain capacity most downstream of Rulo (RM498) where over 600 miles of private levees were constructed, and 60% of those encroach on the 3,000 foot recommended floodway width. Tr. 8659:4-17 (Shumate), DX1207-0016, DX1207-0037. Following the 1993 flood, levees continued to back up water on other levees or lowland areas, so the Corps again recommended that states and tribes ensure proper siting of levees. Tr. 8731:20-8732:3 (Shumate), DX0465-0016 to -0017.

The trend of levees increasing flood heights applies near Plaintiffs' properties.[35] After

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35 Other nearby levees have similarly been erected and raised. The private levee just

the 1984 flood, a Corps hydrology analysis found that a proposed "Binder levee" in Holt County would have a "substantial impact on flood heights," and would decrease the level of protection for the levee on the opposite bank. Tr. 8659:19-8660:9, 8660:16-22, 8661:8-8662:8, 8664:1-8665:3 (Shumate), DX1214 at 1, DX3005-49. The levee sponsor built it anyway along the same alignment, and it is now known as non-federal levee Holt 10. Tr. 8666:13-17 (Shumate); 3430:24-3432:25 (Cunningham). *Compare* DX1214-0003 and DX1209 at 1-2. As of 2010, Holt 10 is more than three feet higher at the downstream end than the proposed alignment. Tr. 8670:20-8671:21 (Shumate), DX1176, DX0970-0021. The Union Township levee sponsors were similarly warned of adverse stage effects likely from levee-reactivation, but it was nevertheless constructed and later raised to higher than the elevation proposed in 1985. Tr. 8665:5-8666:12, 8666:19-8667:12, 8668:5-8669:9, 8670:4-18, 8673:24-8674:12 (Shumate). *Compare* DX1213 at 5-8 with DX1209-0003 and -0005; DX1207-79. Holt County No. 9 consisted of disparate or nonexistent levees, then was consolidated. Tr. 8654:4-8655:2 (Shumate). *Compare* DX1207-92[36] and DX1209-0009. The Rushville-Sugar lake levee was a series of several disjointed levee units that was later consolidated and raised. Tr. 8652:23-8653:14 (Shumate) 3913:3-3914:1, 3916:2-25 (Frakes),

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downstream of the Cunningham Farms property (RM494-499) was relocated closer to the river (240 feet from the bank) sometime after 1989, which further reduced the existing bridge constriction to only 1,500 feet. Tr. 8655:3-11, 8759:18-8762:16 (Shumate). *Compare* DX1207-0092 and DX1209 at 1. Between 2007 and 2010, that levee was raised or strengthened. Tr. 8771:8-8772:13 (Shumate), DX1190, DX3005-89. The Canon levee (RM483 to RM486), an unincorporated unit on 1981 maps, is now a non-federal unit with a 35-year overtopping frequency. Tr. 8653:15-8654:10 (Shumate). *Compare* DX1207-0093 and DX1209-0009. At Bean Lake, immediately downstream of Rushville-Sugar Lake, the existing levee is higher than an elevation determined to raise the elevation of the 100-year flood by more than one foot. Tr. 8648:19-8650:10, 8651:11-8652:16, 8657:17-8658:10 (Shumate), DX0981, DX1207-0098.

[36] The disparate private levee units depicted on the maps within DX1207 are also listed in Tables. *See* DX1207-0040 to -0050.

DX1207-0097, DX0917. The current overtopping frequencies for the non-federal levees is as follows: 10-year for Union Township, 15-year for Holt 10, 35-year for Holt 9, and 25-year for Rushville-Sugar Lake.[37] Tr. 8626:9-17 (Shumate), DX0970-0016 and -0023, DX3005-22.

Plaintiffs with private levees testified about how both they and nearby neighbors had increased levee heights and placed levees immediately adjacent to the riverbed during the 1990s and 2000s. *See* Table 6 at Column P. Some of those levees either did not exist as of 1981, or were disparate levee units located farther from the river bank. Tr. 3402:2-11 (Cunningham), 3871:1-7, 3913:3-3914:14 (Frakes). *See also* DX1207-0092 (depicting area immediately south of "Osgood" levee with no levee where the existing Green levee is located) (Green). None of the Plaintiffs who own private levees (Green Trust, Ideker, Hildebrandt, and L&H Investments)[38] obtained permits from their local authority, though some, if not all, are within regulated floodplains. Tr. 2956:1-6, 2958:16-2959:13 (Green), Tr. 3707:6-3708:2 (Hildenbrandt, B.); Tr. 3623:11-3625:7 (Larson); DX0074. For example, the Ideker property is within Flood Hazard Zone AE, which is covered within the Holt county regulation and requires a permit for development, but Mr. Ideker did not obtain a permit to raise and extend his levee. Tr. 4184:20-4186:1; Joint Stipulations of Facts at 10, ¶¶ 44, 46 (ECF No. 187), DX152-0002 to -0003. The Corps does not know precisely the extent of floodplain improvements over time. Tr. 12617:4-15 (Kneuvean).

Increased flood stages resulting from levee construction, raising, or relocation has been described in recent Corps engineering analyses and scientific publications. Following the 2011 flood, a report analyzing proposals to set back levees described adverse effects of

[37] Roads and bridges also impede flows and raise flood stages. The railroad bridge just south of Big Lake, which Plaintiffs agree impedes flood flows, is a similar height as the Holt 10 levee. Tr. 8675:3-8677:13 (Shumate), Tr.3563:4-16 (Binder), Tr. 6205:2-6206:8 (Tofani), DX1219.
[38] Buffalo Hollow Farms also has a private levee. Mr. Schneider did not testify about a permit.

levee construction. Tr. 8741:21-8744:3 (Shumate), DX1174-0020 ("construction of a levee removes flow area available for the passage of flood waters . . . In response, velocities increase and water surface elevations increase to obtain more flow area."). The Corps estimated that setting back the L-575 levee from its 2011 location would lead to stage decreases of 0.5 to 4-feet for a 100-year flood.[39] Tr. 1965:19-23, 1968:9 (Ettleman), PX0269. Another 2011 article authored by Plaintiffs' trial consultant Dr. Nicholas Pinter confirms "that levees increase flood levels is subject to little disagreement." Tr. 10631:18, 10632:9-17, 10633:4-10635:3 (Mussetter), PX2229 at 2-3 (quoting a 1995 Government Accountability Office article describing the effects of levees during the 1993 flood). Most Plaintiffs in the Kansas City District assert claims over property behind non-federal levees.

e. Levee failures by year

Federal levee failures are infrequent, yet the non-federal levees along the Missouri River have a history of failure during major floods. Information on levee breaches varies depending on when the breach occurs, and whether personnel are present. Tr. 12720:14-12721:2 (Kneuvean). Table 2, attached hereto, summarizes some of the known failures of federal and non-federal levee systems.[40]

Following the 2011 L-575 breach, the Corps' Engineering Research and Design Center ("ERDC"), an independent and highly-qualified analysis team, studied whether the chute impacted flow patterns during the 2011 flood. Tr. 9371:19-9372:6 (Pridal). ERDC developed a 2-D floodplain model that illustrated that the kink point had a big effect on flow velocities,[41] that flows near the chute proceeded downstream with little sideways diversion, and that flows near an

[39] L-575 sponsors rejected the setback option estimated to result in the described stage reductions, and chose a setback location closer to the river. Tr. 1969:24-1970:16 (Ettleman).
[40] Corps records do not detail pre-1993 non-federal repairs. Tr. 12639:9-11 (Kneuvean).
[41] Removing the kink lowers velocities at the breach. Tr. 9387:2-20 (Pridal), DX1088-74.

access road upstream of the breach circulate, but then are redirected downstream before you get to the breach location. Tr. 9379:16-9381:23 (Pridal), DX1088-0041. The study found that the levee alignment concentrated high-velocity flow along an area of lower elevation adjacent to the levee toe along the 10-mile length of the model, and that removing the chute resulted in only minor changes in velocity. Tr. 9388:4-9390:16 (Pridal), DX1088-0005 to -0006.

15. Type and Extent of Flooding in Each Flood Year after 2004.

The Missouri River Basin experienced severe drought conditions in the Lower Basin from 2000 to 2006, and the Upper Basin from 2000 to 2007. Tr. 6865:18-6866:6 (Farhat); Tr. 10787:17-10788:2 (Woodbury); DX3015-24. These conditions were followed by years of high precipitation and runoff. Tr. 10787:18-25 (Woodbury); *see also* Tr. 12969:25-12970:2 (Webb). Since those drought periods ended, above-average runoff conditions have prevailed throughout the basin. Tr. 6868:15-23, 7095:17-24 (Farhat). Post-2006 fluctuations in precipitation levels have also been of larger magnitude than those in the past, as evidenced by reservoir elevations in 2007 at the lowest level in history; in 2011, at the highest level; and with a drought following in 2012. Tr. 6869:10-6870:2 (Farhat).

To evaluate weather data, one must consider total runoff, and the timing and location of precipitation. Within the historic record reaching back little more than 100 years, nine of the ten highest years of total runoff occurred after 1975, and two of those in 2010 and 2011. Tr. 6866:5-10 (Farhat); DX0536-0033, DX0559-0039 to -0040. Mark Anderson, the retired director of the USGS Dakota Water Science Center, explained that flows from the fourteen tributaries into the Missouri River below Gavins Point Dam, [42] have increased since 1960 and

[42] Starting just below Gavins Point Dam, tributaries include: James River (RM 800), Vermillion River (RM 772), Big Sioux River (RM 734), Floyd River (RM 731), Little Sioux River (RM 669), Solider River (RM 664), and Boyer River (RM 635); the Platte River (RM 595); the

have become more variable. Tr. 7236:17-7237:19; 7268:1-3 (Anderson); DX1289-0016; Tr. 12976:22-12977:1 (Webb). Annual tributary flows at the James, Big Sioux, Little Sioux, and Platte Rivers have trended upward from 2006 to 2012. Tr. 7247:21-7248:9; 7257:17-25; 7261:7-13; 7263:12-16 (Anderson). These trends translate to large water volumes entering the River upstream of many Plaintiffs and below the last mainstem reservoir. Tr. 7264:11-7265:10 (Anderson). Decadal averages of streamflow comparing 1960-1969 and 2003-2012 shows the following trends:

1) James River flows, upstream of 40 plaintiffs, have increased 259%, or 110,317 more acre-feet per year.[43] Tr. 7254:7-7255:19 (Anderson).
2) Big Sioux River flows, upstream of 38 plaintiffs, have increased 136%, or 97,121 more acre-feet per year. Tr. 7259:2-14 (Anderson).
3) Little Sioux River flows, upstream of 31 plaintiffs, have increased 98%, or 53,859 more acre-feet per year, which added almost double the volume of water in the Missouri River from period to period. Tr. 7261:14-24 (Anderson).
4) Platte River flows, upstream of 24 plaintiffs, have increased 27%, or 117,274 more acre-feet per year. Tr. 7263:17-23 (Anderson).

The increases in the James and Big Sioux River are the largest in the United States from 1960 to 2002. Tr. 7251:1-6 (Anderson). The magnitude and frequency of runoff in extreme years has increased at Sioux City. Tr. 13853:10-13854:1 (McCarthy), DX0192-0061, Fig. 25.

a. <u>2007 Flood Year</u>[44]

i. Weather/Flooding

Illustrating the variability of the basin, in 2007 the lower basin was wetter than average but the upper basin was drier than average. Tr. 6878:16-18 (Farhat). South Dakota experienced

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Weeping Water Creek (RM 568.7), Nishnabotna River (RM 542), Little Nemaha River (RM 527), Tarkio River (RM 507), Big Nemaha River (RM 495), and the Nodaway River (RM 463). DX3014-77.

[43] Other gauge readings upstream on the James River show even larger increases up to almost 400 percent. Tr. 7239:11-20 (Anderson).

[44] Plaintiffs' Complaint was filed more than six years after the 2007 flooding occurred, and thus beyond the six year statute of limitations. Although the United States has not yet moved to dismiss these claims at this stage, it will likely do so at a later stage, if necessary.

the fourth wettest May, and North Dakota the eighth wettest year, in a 113 historical record. Tr. 10794:8-25, 10795:1-5 (Woodbury), DX3015-28. Local precipitation was another important meteorological factor. Tr. 2353:15-20 (Schneider); DX0933, G. Hildebrandt Dep. Tr. 44:9-11; Tr. 1571:20-25 (Husz); Tr. 2967:15-19 (Green); Tr. 3451:20-3452:2 (Cunningham). River gages near Plaintiff properties reviewed by the Missouri River Forecast Center also recorded rain greater than half an inch occurring during the two weeks prior to flood events. Tr. 11801:15-20 (Predmore), DX0096, DX0097, DX0099.

At the George Neale Farm, local precipitation exceeded the 90th percentile for the month of May with rainfall accumulating in a week-long period. Tr. 10803:12-10804:2 (Woodbury), DX3015-37. While much of the runoff in the Upper Basin was stored in reservoirs, then at record low levels, the unregulated runoff in the Lower Basin produced significant tributary and mainstem flooding. Tr. 7095:20-22, 7157:16-7160:1 (Farhat), DX3001-226, -243; DX0480; DX0094.

ii. Reservoir Operations

The System had record low storage on March 1st at 22.7 MAF below the base of the annual flood control zone, and the upper three reservoirs were 31-34 feet below normal. Tr. 7157:3-8 (Farhat); DX0480. Due to drought, the navigation season was cut thirty-five days short and annual Gavins Point releases were at record lows, below even the annual average in 1997.[45] Despite these low releases, stages in the lower river were high because of high tributary flows, and in accordance with Manual provisions, the Corps allowed flows below navigation targets to reduce flood risk. Tr. 7157:20-7159:2 (Farhat), DX 3001-243. Operations for birds were also

[45] 1997 was the highest runoff year above Sioux City since modern record-keeping began with annual runoff at 49.0 MAF and system storage peaked at 71.7 MAF. Tr. 7391:11-7392:15 (Farhat); Tr. 13527:15-13527:16 (Hoerling), DX0497, DX0500.

delayed due to high flows in early May and, when implemented, cycling was utilized to reduce flood risk. Tr. 7160:4-20 (Farhat). System releases were a small percentage of the total flow at the time of the peak flow in May. Tr. 10789:18-21 (Woodbury), DX3015-25.

b. <u>2008 Flood Year</u>

i. Weather/Flooding

In 2008 the Basin recovered from the drought. Tr. 7160:24-7161:6 (Farhat); DX0481. Iowa experienced very heavy rainfall leading to the wettest record in 114 years. Tr. 10797:1-5 (Woodbury) DX3015-29. Heavy and unprecedented rains were also recorded in Montana, South Dakota, Nebraska and Missouri. Tr. 10797:6-13 (Woodbury), DX3015-29, Tr. 13500:12-14 (Hudson), DX0094. The Missouri River Forecast Center recorded rain greater than half an inch occurring during the two weeks prior to alleged flood events. Tr. 11801:15-20 (Predmore), DX0096, DX0097, DX0099. Plaintiffs also recall, and documented, the heavy precipitation in 2008. Tr. 2140:13-2142:13 (Woltemath), 1572:18-24 (Husz), Tr. 3452:3-4 (Cunningham), Tr. 1927:3-16 (Ettleman); PX1435 at CLMT-370-370-564.

ii. Reservoir Operations

System storage on March 1st was up from 2007, but still below the normal start of the runoff season, and the upper three reservoirs were 26 to 35 feet below normal levels. Tr. 7161:15-20 (Farhat); DX0481. Gavins Point annual releases averaged 14,600 cfs, similar to the record low in 2007, and again there were high inflows from lower basin tributaries. Tr. 7162:7-10; 7162:11-16 (Farhat), DX 3001-247. The Corps reduced flows to below navigation targets at Sioux City and Nebraska City from April through September to reduce lower basin flood risk. Tr. 7162:17-22 (Farhat). Operations for birds started in late May, due to high tributary flows in the lower river, and cycling was used. Releases during bird nesting season were lowered in June

and July because of high tributary inflows and increased later in the summer when tributary flows dropped off. Tr. 7163:18-7164:5 (Farhat). System releases were a small percentage of the peak flow. Tr. 10789:18-25 (Woodbury), DX3015-25.

c. <u>2010 Flood Year</u>

i. Weather/Flooding

During the spring and summer of 2010, the Missouri River and its tributaries experienced extensive flooding after extensive and heavy spring rains, and very heavy plains snowpack. Tr. 7187:9-7189:16 (Farhat); Tr. 1292:7-12 (Jackson); Tr. 2845:22-2846:3 (Peeler); Tr. 3505:15-20 (Rouse); Tr. 1561:21-23 (Husz); Tr. 2967:15-19 (Green); Tr. 3452:5-7 (Cunningham); *see also* Tr. 12970:22-25 (Webb). Regional precipitation from Sioux City to St. Joseph was much above average and Nebraska and South Dakota had June precipitation of more than 200 percent of average. Tr. 10797:14-10798:2 (Woodbury), DX3015-30, DX3015-31. As a result, runoff during 2011 was 156% of normal and generated the third highest runoff in the last sixty-five years in St. Joseph. Tr. 10806:14-15 (Woodbury); DX0483 at 1. River gages near Plaintiff properties also recorded rain greater than half an inch occurring during the two weeks prior to flood events. Tr. 11801:15-20 (Predmore), DX0096, DX0097, DX0099.

ii. Reservoir Operations

Total System storage on March 1st was 2.2 MAF below the normal start of the runoff season. Tr. 7161:15-20 (Farhat); DX0481. Operations for birds started in early May, with cycling, 3-4,000 cfs up one day and two days down, until mid-June. Tr. 7193:18-7194:13 (Farhat). In order to assist with downstream flooding, on June 22, the Corps implemented its largest single-day reduction in releases from Gavins Point, from 33,000 cfs to 15,000 cfs due to heavy rain along the lower river causing water to approach the top of levees. Tr. 7190:22-

7191:15; 7194:24-7195:4 (Farhat). From late June until August releases were driven by the need to evacuate stored flood water, not operations for the birds. Tr.7195:7-9 (Farhat). In 2010 enough runoff entered the System that Garrison, Oahe, and Fort Randall all reached their exclusive flood control zones and Fort Peck, which started the year twelve feet below normal, refilled to the base of its annual flood control zone. Tr. 7161:15-20, 7191:17-7192:7 (Farhat), DX 3001-263. System releases in 2010 were a small percentage of the total flow at peak flow. Tr. 10789:18-25 (Woodbury), DX3015-25.

d. 2011 Flood Year

i. Weather/Flooding

The 2011 runoff and flooding was unprecedented in magnitude and duration. The untimely combination of events caused record river levels and extensive flooding in the Missouri River Basin from June through August. Tr. 13858:16-13859:2 (McCarthy). During the winter and spring of 2010-2011, record snow fell across a large portion of the northern Rocky Mountains and eastward into the Northern Plains. Tr. 13858:16-13859:2 (McCarthy), 10798:14-10799:9 (Woodbury); DX3015-32. A cool spring held snowpack in place later than usual, and a rapid snowmelt coincided with record-setting rains in May and early June over Montana and western North Dakota. Tr. 13843:1-13848:2, 13853:1-6 (McCarthy); DX3007-07. Despite summer drought conditions in the lower basin, it was extremely wet in portions of the Montana, Wyoming, Colorado, and the Dakotas. Tr. 13500:20-13501: 2 (Hudson), DX0094. In addition to record highs in mountain snow water equivalent, May precipitation was 400 percent of average, and above Sioux City runoff was 320% above average. Tr. 13843:1-13844:4, 13847:13-13849:14 (McCarthy); DX3007-07; DX0192-0044. The high snowpack and delayed snowmelt contributed to a May-July runoff twenty percent higher than in 1997. Tr. 13853:1-6

(McCarthy); DX0192-0048, -0054, -0061, Fig. 25. The runoff in 2011, totaling 61 MAF, was the highest in the upper basin since 1898 and 246% of normal. DX0484 at 1. Runoff was twenty-five percent greater than the next highest runoff year in 1997. Tr. 7116:2-7117:22 (Farhat); Tr. 10806:14-15 (Woodbury).

The flood was the first event since the dams closed when the flows at Nebraska City (RM 562.6) were higher than a 25-year flood level, and in 2011, there were 159 days of flood flows, which is more than double the most days of flooding experienced since at least 1930. Tr. 9354:10-9355:16 (Pridal), DX1070-0015, Figure 3 (noting that the "2011 event dwarfs all other events which occurred on the historic Missouri River," and that the "event was unique in the historic record with excess floodplain energy at a very high level for a prolonged duration.") The high-magnitude flows also carried far less sediment than would be expected based on the historical record for flows of that magnitude, and therefore the sediment-starved water had higher energy available to erode material from the floodplain; the river then deposited high amounts of eroded sediment as flows and energy decreased toward the tail end of flooding. Tr. 9355:17-9358:6 (Pridal), DX1070-0017. Post-flood repair work on BSNP structures was approximately 20 to 25 times the typical yearly volume, and flood-fight costs in the Kansas City District were more than fifteen times the costs in non-flood years. Tr. 9326:10-24 (Pridal), 12674:11-12676:21 (Kneuvean). Following the flood, an independent technical panel investigated the effectiveness of the Corps' operations and experts and scholars have examined the meteorological causes of the 2011 flood. Tr. 13629:20-13630:7 (Grigg), DX0192, Tr. 13522:2-13523:7 (Hoerling), DX0185, DX0186.

ii. Reservoir Operations

The System storage on March 1st was 57.6 MAF, however all 2010 runoff had been evacuated and the runoff season was at the base of the annual flood control zone by January 27th. Tr. 7098:8-17, 7137:15-7138:13 (Farhat); DX0484. As a result of the record runoff, the Corps released a record 160,000 cfs from Gavins Point, in contrast to the then-record 70,000 cfs released in 1997. Tr. 7392:13-15 (Farhat), DX 3001-265. From March through early May, due to very high tributary flows, operations were focused lower releases for downstream flood control. Tr. 7131:16-22; 7121:15-24 (Farhat). In 2011 there were no reservoir operations for endangered species due to high flows. Tr. 7122:8-22; 7131:19-22 (Farhat), Tr. 13687:8-20 (Grigg).

e. <u>2013 Flood Year</u>

i. Weather/Flooding

A drought developed in 2012 that remained over much of the basin in early 2013. Tr. 7202:1-4 (Farhat), *see also supra*. Gavins Point releases were reduced due to high flows downstream of Nebraska City from heavy localized rains in Nebraska, Missouri, Kansas and Iowa. Tr. 7203:8-20 (Farhat). The Big Nehama River had the second highest flows of record. *Id.* May rainfall in the lower basin was also much above normal. Tr. 10799:12-14 (Woodbury), DX3015-33, DX0094. Plaintiffs in Iowa, Nebraska, and Kansas recall heavy rainfall in May 2013. Tr. 1081:12-16 (Sieck), 3639:12-21 (Larson), 2846:24-2847:2 (Peeler); 2967:15-19 (Green); *see also* Tr. 11801:15-20 (Predmore), DX0096, DX0097, DX0099.

ii. Reservoir Operations

System storage on March 1, 2013 was 8.3 MAF below the normal start of the runoff season, and the upper three reservoirs were 10 to 12 feet below normal levels. Tr. 7161:15-20 (Farhat); DX0486; *see also* Tr. 12969:20-23 (Webb). Based on total System storage, navigation

support was at minimum service until July 1st. Tr. 7202:19-25 (Farhat). Gavins Point releases were reduced in early April, late May through early June, in response to high downstream tributary flows due to heavy localized rain, including the second highest flows of record on the Big Nemaha River. Tr. 7203:8-14; 7204:6-19 (Farhat), DX 3001-275. The reduced flood control flows meant navigation targets at Sioux City and Nebraska City were not met. Tr. 7203:15-24 (Farhat). Bird operations were started in mid-May, then reduced in response to heavy rainfall downstream. Tr. 7204:9-15 (Farhat).

f. <u>2014 Flood Year</u>

i. Weather/Flooding

In 2014 there was high run off in the upper basin and a low runoff in the reach between Sioux City and St. Louis. Tr. 7205:2-18 (Farhat); DX3001-276. However, June brought extreme rainfall to the lower basin. Tr. 7206:22-7207:9 (Farhat). Plaintiffs recall a big rain in August 2014. Tr. 2142:14-19 (Woltemath). The unregulated runoff above Sioux City, Iowa was 140 percent of normal runoff, due to record inflows from the Big Sioux more than 20,000 cfs above the previous record. Tr. 7258:4-23 (Anderson); 7205:14-15 (Farhat); 10790-1-13 (Woodbury), DX0536-0021, DX0094. Plaintiffs in Iowa and Missouri also recall rainfall preceding flooding in 2014. Tr. 2847:17-21 (Peeler); Tr. 2672:15-2673:9 (Olson); *see also* Tr. 11801:15-20 (Predmore), DX0096, DX0097, DX0099.

ii. Reservoir Operations

The System storage on March 1st was 5.4 MAF below the normal start of the runoff season, and the upper three reservoirs were 5 to 12 feet below normal levels. Tr. 7205:20-24 (Farhat); DX0536. Based on total System storage, navigation support was at intermediate service until July 1st. Tr. 7206:4-7 (Farhat). The Corps reduced Gavins Point releases to a

minimum 10,000 cfs in response to the extensive June rainfall, which lowered the peak stage at Sioux City. Tr. 7206:22-7207:9 (Farhat). Unusually high runoff in August and September forced evacuation of flood water, thus higher releases, later than normal in the year. Tr. 7206:9-16 (Farhat). Releases were adjusted slightly in mid-May for bird operations, but were ceased when releases were reduced in June in response to the Big Sioux flood. Tr. 7207:16-24 (Farhat), DX 3001-281.

16. Individual Takings Claims of Plaintiffs

Trial showed that Plaintiffs' properties were flood-prone before the Corps changes were implemented, and became no more so as a result of the Corps changes. Most of the properties were subject to periodic historical flooding, even after the reservoir system was completed, and that flooding was often of severe magnitude. Forty of the 44 properties were located within designated flood hazard zones at the times of the flooding alleged. Joint Stipulations of Fact, Ex. 1, ECF No. 187-1. As Luis Rodriguez, Director of FEMA's Engineering and Modeling Division, described, at least portions of twelve of the 44 properties were located are within the regulated floodway, [46] and many more were adjacent to a floodway; suggesting they were subject to an even higher risk of flooding.[47] DX0001, DX0002, DX0089, DX2073; Tr. 10683:2-8, 10684:3-18, 10692:5-13, 10693:3-10699:2 (Rodriguez).

In many instances, Plaintiffs' properties are located in areas of the River where the pre-existing capacity of the River was so low that flows are likely to be exceed the in-banks capacity

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[46] The floodway is an area within a special flood hazard area that encompasses "the channel of a stream plus the adjacent floodplain areas that must be kept free of encroachments so that the 1 percent annual chance flood can be carried without substantial increases flood heights." Tr. 10684:22-10685:1 (Rodriguez). Floodways involve higher flow velocities, tend to be more hazardous, and carry higher risk. Tr. 10684:10-18. (Rodriguez).

[47] Large portions of the Neale (Claim ID 309) and Adkins (Claim ID 2B) properties, and the entirety of the Hildebrandt (Claim ID 131) property, are within the floodway. DX0002-0009, -0010, -0020; Tr. 10697:7-13; 10697:9-14; 10698:24–10699:2 (Rodriguez).

of the channel every two years.[48] Tr. 10073:3-24, 10074:4-10076:6 (Mussetter), DX3014-121, DX3014-122. These areas with channel capacity as low as 50,000 cfs, and other still-low capacity reaches of the river, were highly prone to flooding before any of the actions alleged.[49] Many of the properties adjacent or near the channel lay on land previously within the river bed that accreted (and remains in existence) only as a result of the Corps' continued operation of the BSNP. Tr. This accreted land, comprised of river-sediment deposits, and land overlying historic river channels is composed of highly permeable soils prone to seepage. Tr. 8000:14-8001:3, 8002:10-8004:7 (Remus), 12350:15-12351:1 (Schaefer), DX1122. For the agricultural properties, Plaintiffs were generally able to plant, farm, and harvest crops on their land in the years following the flooding alleged, so there is no evidence that the flooding changed the character or nature of the land. *See* Tables 3-7 at Column I. Information concerning the location, date of acquisition, years of flooding, distance from MRRP projects and notches, information about existing wetland easements, dates of levee modifications, and historic conditions for each property within a region are set forth in the attached Tables 3-7.

III. **ANALYSIS SECTION**

Plaintiffs assert both temporary and permanent physical takings caused by occupation of, and injury to their property as result of flooding caused by the reservoir System changes and

[48] The reaches where the 50% annual exceedence probability flow is near or above the in-bank capacity are between approximately River Miles 420-425, 478, 505-518, 538-562, 573, 637, 658, 668, 680-683, and 692, which are near the Frakes, Buffalo Hollow Farms, Cunningham Farms, Saunders, Binder, Cunningham Trust, Drewes Farms, Ideker Farms, Garst, L& H Investments, Barnes, Schemmel, Hi-Tech Farms, Payne Valley Farms, KMJ Farms, Ettleman, George Neale Farm, Blodgett Farms, Olson, and Archer properties. DX3014-121, DX3014-122

[49] Channel capacities, and therefore flow rates at flood stage vary. From RM 675 to 710, channel capacity is near or below 60,000 cfs, and from RM 540 to 560, and near RM 513 channel capacity is near or below 80,000 cfs. DX3014-121, DX3014-122. Meanwhile flood stage varies from 120,000 cfs at Sioux City to only 85,000 at Nebraska City, to 95,000 cfs at St. Joseph. Tr. 7084:22-7085:9 (Farhat). While navigation service at Sioux City is only one-fourth of flood stage flows, it is approximately half of flood stage flows farther downstream. *Id.*

project construction. Pls.' Pre-Trial Mem. at 6, 8, ECF No. 195. They have not specified which of the 44 representative plaintiffs have permanent or temporary claims over which portions of their properties. In pre-trial briefing, Plaintiffs asserted their claims were "based upon a theory of actual causation that but for the Corps' System and BSNP Changes . . . the flooding that is alleged . . . would not have occurred or would have been less severe or of shorter duration . . . ." *Id.* at 8. At trial, Plaintiffs asserted that the Corps actions were not the sole cause of flooding, but were instead significant contributing factors to the flood, and that Corps actions combined with other factors like rain to cause the flooding. That is insufficient to carry Plaintiffs' burden.

17. Plaintiffs' Burden of Proof

The plaintiff in an inverse condemnation action bears the burden of proof. *Ridge Line, Inc. v. United States*, 346 F.3d 1346, 1355 (Fed. Cir. 2003). First, Plaintiffs must identify the precise action that is the subject of the claim. *Acceptance Ins. Cos. v. United States*, 583 F.3d 849, 855 (Fed. Cir. 2009) (an alleged taking "consisting of several distinct [government] actions viewed in concert" is too broad of a characterization because it does not pinpoint at what step in the order of events constituted conduct that would be a taking.) Once Plaintiffs identify the precise action, they "must establish that treatment under takings law, as opposed to tort law, is appropriate under the circumstances." *Ridge Line*, 346 U.S. F.3d at 1355; *Acceptance*, 583 F.3d at 855. That is because "not every 'invasion' of private property resulting from government activity amounts to an appropriation," and "[o]nly under limited circumstances may the property-owner be compensated for a taking." *Id.*; *Nicholson v. United States*, 77 Fed. Cl. 605, 616 (2007). Whether a claim is a tort or a taking "requires consideration of whether the effects [Plaintiffs] experienced were the predictable result of the government's action, and whether the government's actions were sufficiently substantial to justify a takings remedy." *Ridge Line*, 346

F.3d at 1355.[50]

If a takings remedy is potentially available, then, as a threshold matter, the plaintiff must establish a cognizable Fifth Amendment property interest that is asserted to be the subject of the taking. *Ridge Line,* 346 at 1355; *Hearts Bluff Game Ranch, Inc. v. United States*, 669 F.3d 1326, 1329 (Fed. Cir. 2012). "[I]f the court concludes that a cognizable property interest exists, it determines whether that property interest was 'taken'" by the Government action at issue. *Hearts Bluff*, 669 F.3d at 1329 (citations omitted).

Plaintiffs did not clarify which of their claims they allege to be permanent takings and which to be temporary; therefore, the United States explains herein both legal standards. The Supreme Court has recognized "two relatively narrow categories" of per se takings – permanent physical occupations, and the deprivation of all economically beneficial use of land. *Lingle v. Chevron U.S.A. Inc.*, 544 U.S. 528, 538 (2005). In order to prove a per se physical taking that is compensable under the Fifth Amendment, plaintiffs must prove that their land was permanently subject to a physical invasion by floodwaters. *United States v. Kan. City Life Ins. Co.*, 339 U.S. 799, 810 (1950). In all other cases other than the two categories of per se takings, courts examine "the 'taking' question by engaging in essentially ad hoc, factual inquiries . . . ." *Kaiser Aetna v. United States,* 444 U.S. 164, 175 (1979) (citation omitted); *accord Lingle*, 544 U.S. at 538-39 (citing *Penn Cent. Transp. Co. v. City of New York,* 438 U.S. 104, 124 (1978)). For a temporary flood takings claim, the Court must consider (1) the duration of the physical invasion or interference, (2) "the degree to which the invasion is intended or is the foreseeable result of authorized government action," (3) "the character of the land at issue," (4) "the owner's

[50] The tort-taking distinction is a threshold question because tort claims are not within the Court's jurisdiction and the United States has immunity from tortious flood damage claims. *Ridge Line*, 346 F.3d at 1355; 28 U.S.C. § 1491(a)(1); 33 U.S.C. § 702c.

reasonable investment-backed expectations regarding the land's use," and (5) "[s]everity of the interference . . . ." *Ark. Game & Fish Comm'n v. United States*, 568 U.S. 23, 38-39 (2012) (internal quotation marks and citations omitted). These factors are not exclusive and must be applied to the parcel as a whole.[51] *Penn Cent. Transp. Co.*, 438 U.S. at 130-31.

Beyond these requirements, Plaintiffs must also establish that the acts that allegedly caused the taking were authorized government action and either "appropriate[d] a benefit to the government at the expense of the property owner, or at least preempt[ed] the owners['] right to enjoy his property for an extended period of time, rather than merely inflict an injury that reduces its value." *Ridge Line*, 346 at 1356. However, at this phase in the case, the Court will only address the various elements of causation and the severity and duration of flooding on the representative parcels (but not the parcel as a whole).

18. Causation

a. Actual Causation

Plaintiffs must establish that the government's conduct was the actual cause of more flooding than would have occurred without the government conduct.[52] *Cary v. United States*, 552 F.3d 1373, 1379 (Fed. Cir. 2009); *Laughlin v. United States*, 22 Cl. Ct. 85, 101 (1990), *aff'd*, 975 F.2d 869 (Fed. Cir. 1992) (Table Decision); *Accardi v. United States*, 220 Ct. Cl. 347, 358

[51] Because the parties have not put on evidence to determine the parcel as a whole at this phase of the case, an ultimate analysis on the *Arkansas Game & Fish* factors to establish that a taking has occurred (as opposed to finding that some factors have not been met) cannot yet be completed.

[52] Akin to causation is the rule that allegations of government action increasing future risk of flooding cannot support a taking claim. *United States v. Sponenbarger*, 308 U.S. 256, 267 (1939); *Danforth v. United States*, 308 US. 271, 286 (1939); *Stueve Bros. Farms, LLC v. United States*, 105 Fed. Cl. 760, 767–68 (2012), *aff'd*, 737 F.3d 750 (Fed. Cir. 2013). This rule stands even if such increased risk is alleged to be an "unfair" public burden placed on plaintiffs. *Stueve Bros. Farms, LLC v. United States*, 107 Fed. Cl. 469, 489 (2012), *aff'd*, 737 F.3d 750 (Fed. Cir. 2013).

(1979), *aff'd*, 790 F.2d 93 (Fed. Cir. 1986) (Table Decision).

Actual causation is not proven simply because an injury occurred after an agency took an action.[53] *Baskett v. United States*, 8 Cl. Ct. 201, 210 (1985); *Loesch v. United States*, 645 F.2d 905, 914 & n.8 (Ct. Cl. 1981) (per curiam); *Alost v. United States*, 73 Fed. Cl. 480, 495 & n.14 (2006), *aff'd sub nom. Morgan v. United States*, 254 F. App'x 823 (Fed. Cir. 2007) (per curiam). Instead, courts engage in a thorough analysis of expert opinions and other evidence to determine causation, including that which considers the historic context for such intrusions, eliminates alternative causes, determines a clear chain of causation, isolates the amount of the intrusion caused by the government action, and examines whether the amount of intrusion caused by government action changed the character of the land. *Ark. Game & Fish Comm'n v. United States (Ark. Game & Fish III))*, 736 F.3d 1364, 1371-72 (Fed. Cir. 2013). Generalized expert opinions on causation that lack specificity merit little weight. *Loesch*, 645 F.2d at 916 (describing evidence that erosion generally occurred during flooding, but finding evidence relating to the potential for erosion as an end result of dam operation to be "most generalized and lacking in specificity."). Similarly, expert opinions that analyze only a single causative factor without giving "reasonable consideration to other clearly shown possibilities which might serve to explain" the injury, are—at best—"naked," unpersuasive opinions. *Id.* at 915. Further, an expert's inability to explain why his determined "cause" of injury did not create the same injury in other similar circumstances suggests other root causes of the injury. *Id.* at 915 n.9.

The complex, technical question of actual causation cannot be answered with lay witness

[53] Such reasoning of "a causative effect is referred to as *post hoc ergo propter hoc* (after this therefore on account of this)." *Baskett*, 8 Cl. Ct. at 210. Courts reject this reasoning as "neither good logic nor good law." *Volentine & Littleton v. United States*, 169 F. Supp. 263, 265 (Ct. Cl. 1959).

observations because such observations often lack specificity, witnesses lack knowledge of all relevant information, witnesses have faulty memories, and allegations or changes make claimants more aware of perceived damages than they were in the past. *See Leeth v. United States*, 22 Cl. Ct. 467, 486–87 (1991) (cause not discernable based on lay witness observation of water surface); *Alost*, 73 Fed. Cl. at 495 (meriting little weight to lay witness "before-and-after" comparison based on incomplete "before" information because it was vague and Plaintiffs often only owned land a few years before the agency action); *Baskett*, 8 Cl. Ct. at 210 (lay witness erosion observations did not prove causation, as publicity made landowners more aware of erosion than before);[54] *Loesch*, 645 F.2d at 914 n.8 (lay witnesses erosion observations did not prove increase prove causation, as project construction made landowners more aware of erosion than before).[55]

The Court must consider the history and characteristics of the property in assessing whether the government action caused the flooding at issue, including but not limited to, the nature and extent of previous flooding on the property, whether the property had always been a risk for unpredictable major floods, if the property is located in a natural floodway, and its location in relation to upstream tributaries that might flood. *Sponenbarger*, 308 U.S. at 265–

[54] In *Baskett*, court found plaintiffs' opinions based on their observations of erosion "before-and-after" the agency action were flawed, in part, because "plaintiffs' attentiveness to the banks not only increased dramatically after the installation of the high-lift dams, but in some cases such attention increased due to the publicity surrounding" similar litigation. *Baskett,* 8 Cl. Ct. at 211 n.11.

[55] The *Loesch* court found plaintiffs' "before-and-after" erosion opinions flawed because "[t]he record suggests that plaintiffs generally were really not attentive to river action on their banks prior to construction of the involved dams." *Loesch*, 645 F.2d 914 n.8. "However, after the dams were constructed their attention became more concentrated on their banks in anticipation of erosion problems. It seems clear that erosion in varying degrees was taking place on riverbank properties in these pool areas prior to construction of the dams." *Id.*

66;[56] *Danforth v. United States*, 308 U.S. 271, 286 (1939);[57] *Leeth*, 22 Cl. Ct. at 485-87;[58] *Alost*, 73 Fed. Cl. at 506.[59]

Courts regularly find that flooding of a plaintiff property was caused by heavy precipitation which created natural flooding, despite an agency's releases of those floodwaters or other agency action.[60] *See, e.g.*, *Laughlin v. United States*, 22 Cl. Ct. 85, 87 (1990), *aff'd*, 975 F.2d 869 (Fed. Cir. 1992) (Table Decision); *Hendricks v. United States*, 14 Cl. Ct. 143, 155–56 (1987); *Alost*, 73 Fed. Cl. at 495; *Leeth*, 22 Cl. Ct. at 487; *Bartz v. United States*, 633 F.2d 583, 593 (Ct. Cl. 1980) (per curiam); *Cf. Ark. Game & Fish III*, 736 F.3d at 1368 (specific annual deviations from water control plan that caused flooding were instituted at the request of and to aid agricultural interests). The source of the floodwaters that inundate the property is relevant when considering if the complained-of government action truly caused the taking of which plaintiffs complain. *Laughlin v. United States*, 22 Cl. Ct. at 101-03.[61] For example, while dam operators "pull the

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[56] Courts consider a property's long-time risk of unpredictable major floods and location in a natural floodway in evaluating a taking. *Sponenbarger*, 308 U.S. at 265–66.

[57] Courts have found there would be no taking if government did not place a greater burden of flooding on a property than it bore prior to the government action. *Danforth*, 308 U.S. at 286.

[58] The *Leeth* court determined that plaintiff had failed to make a prima facie taking case that the dam caused backwater on property, as the property had always been subject to natural flooding; drainage was poor; nearby development had increased runoff to property; nearby levee impeded movement of flood waters; and backwater had many causes including bridge constrictions and inflows from upstream river unrelated to dam. *Leeth*, 22 Cl. Ct. at 485–87.

[59] This court noted "[i]t is impossible to know whether the Project caused groundwater seepage and drainage problems without evidence of pre-Project conditions." *Alost*, 73 Fed. Cl. at 506.

[60] Attacks on an agency's discretion in how it provided flood protection, such as releases, do not support takings claims. *See Nicholson*, 77 Fed. Cl. at 622, 624. Allegations "[t]hat a government agency could have forecast more accurately the heavy snowmelt" also does not support a takings claim, and instead such a "theory appears tortious." *Laughlin*, 22 Cl. Ct. at 102-03.

[61] In *Laughlin v. United States*, Plaintiff asserted that subsurface drainage to his farmland had raised groundwater levels that damaged his crops and rendered the land unusable for agricultural purposes. 22 Cl. Ct. at 86. Plaintiff claimed the high groundwater was caused by either or a combination of the Colorado River Reservoir System or the government's accidental creation of a marsh. In assessing causation from the operation of the reservoir system, the court explained

lever" to discharge flood waters; they do not cause the actual climate conditions that can dictate those discharges, such as the amount of rainfall or snowmelt inflows to the System above and below the dam each year; and operators are limited in their ability to regulate significant inflows based on the amount of storage capacity at the reservoir. *Id.*; *Bartz*, 633 F.2d at 592 (releases required due to large upstream inflows, despite already high downstream water levels, were not a taking).[62]

b. Natural, Probable, Cause

The United States is only liable for a taking for damages "directly attributable to government action," not secondary or contributory factors that caused damage. *Bartz*, 633 F.2d at 593 (agency's manipulation of releases from dam played only "secondary role" in flooding as excessive precipitation was the root cause). This "direct attribution" occurs if the injury is the "direct, natural, or probable result of an authorized activity and not the incidental or consequential injury inflicted by the action," as incidental and consequential injuries of an action lie in tort. *Ridge Line*, 346 F.3d at 1355 (quoting *Columbia Basin Orchard v. United States*, 132

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that "due to incorrect early forecasts and an extremely late accurate one, the [agency's reservoir space] was unable to deal adequately with the large water supply of 1983," and large inflows continued through 1987, causing the agency to make corresponding large discharges. *Id.* at 102. The Court determined that the agency had to make the releases, as its "responsibility [was] to regulate flows to minimize the impact of heavy discharges." *Id.* So, to attach liability every time the agency made releases in response to insufficient storage and caused injury to downstream property improperly "make a government agency responsible for whatever climatic conditions nature chooses to deliver." *Id.* The court determined that the large discharges on the Colorado River system were due to natural precipitation causing the exceptional inflow from 1983–1987, not the agency's required releases of those inflows. *Id.*

[62] The *Bartz* court reasoned that "[i]n those excessively wet years the Reservoir's high levels were often accompanied by high downstream water levels of both the Iowa River and its regulated and unregulated tributaries. Faced with the need to reduce the high levels of the Reservoir because of actual or impending heavy rainfalls in the area the Corps had no alternative to increasing the rate of discharge from the dam, despite temporary consequences to downstream farmers." *Bartz*, 633 F.2d at 592.

F. Supp. 707, 709 (1955)); *Big Oak Farms, Inc. v. United States*, 105 Fed. Cl. 48, 58 (2012) (sand and gravel deposits that filled and impaired drainage ditches after flood constituted consequential damages only). The Court must consider "the degree to which the invasion is intended or is the foreseeable result of authorized government action," *Ark. Game & Fish Comm'n*, 568 U.S. at 39, but foreseeability is not sufficient to satisfy the *Ridge Line* test: "Foreseeability and causation are separate elements that must both be shown when intent is not alleged." *Cary*, 552 F.3d at 1379 (parentheses omitted). The agency's knowledge at the time of action that a particular result is *possible* does not mean the action is *probable*, and therefore an agency's written or other recognition of the possibility of a result from an action does not meet this element.[63] *Moden v. United States*, 404 F.3d 1335, 1345 (Fed. Cir. 2005). Even an action that increases the risk of a detrimental result "does not equate to making the detrimental result direct, natural, or probable." *Cary*, 552 F.3d at 1378.

In making this determination Courts look at whether "a succession of events was initiated [by the government action] which, when the events had all occurred in their natural order, deprived the [plaintiff] of the beneficial use of its land." *Cotton Land Co. v. United States*, 75 F. Supp. 232, 233 (Ct. Cl. 1948). The *Cotton Land* case involved "a concrete beginning (the dam), an ending (the flood), and in the middle, a series of steps each inevitably following from the one before it" with only one possible source of causation. *Cary*, 552 F.3d at 1379; *Nicholson*, 77 Fed. Cl. at 618. A critical question, therefore, is what set the chain of events in motion and then whether each event inevitably followed to cause the result. *Cary*, 552 F.3d at 1379. If the agency action did not even set the chain in motion, it did not cause the resulting harm under the actual

[63] This element has also been described as something that is "likely" to occur. *Baird v. United States*, 5 Cl. Ct. 324, 330 (1984) (citing *Bettini v. United States*, 4 Cl. Ct. 755, 760 (1984); *Berenholz v. United States*, 1 Cl. Ct. 620, 628 (1982), *aff'd*, 723 F.2d 68 (Fed. Cir. 1983) (Table Decision)).

causation element, much less would it be the direct, natural, probable result of the action. *Nicholson*, 77 Fed. Cl. at 617 ("Put quite simply, the construction of the floodwalls did not cause the flooding; the flooding was caused by the storm surge."). If the causation chain involves a series of intermediate decisions, some that increase the risk of harm but others that decrease the risk of harm, a clear causation chain is not the direct, natural, and probable cause. *Cary*, 552 F.3d at 1379. An agency's reasonable investigation into the results of a complained-of action before it takes that action can bear on whether a result was foreseeable. *Ark. Game & Fish Comm'n III*, 736 F.3d at 1373 ("[A] reasonable investigation . . . would have revealed that the [agency action] would result in a significant increase in the number of days of flooding . . . .").

Plaintiffs cannot prove causation simply by showing that government action was a contributing factor to the harm. The legal standard requires that the injury be the direct, natural, and probable result of government action. *Columbia Basin Orchard*, 132 F. Supp. at 709 (even if agency's discharges from dam were contributing factor to injurious overflow or seepage, such damages were not the natural, probable result of the discharges); *Nicholson*, 77 Fed. Cl. at 618 (even if floodwalls were a contributing factor to flooding, the flooding was not directly attributable to floodwalls);[64] *Thune v. United States*, 41 Fed. Cl. 49, 54 (1998) (agency ignited the fire so destruction was "partially attributable" agency, but such a result "was not a direct, natural and probable consequence of the project functioning as designed.")

c. Intervening or Alternative Cause Breaking Chain of Causation

The court must also determine that "no break in the chain of causation existed between

[64] The *Nicholson* court explained that "[e]ven if Plaintiffs could prove that the Corps' installation of floodwalls contributed to the hurricane's destruction, it would not follow that the flooding was 'directly attributable' to the Corps' protective measures, as opposed to the severe nature of the storm." *Nicholson v. United States*, 77 Fed. Cl. at 618.

the suspected government authorized action and the injury." *Cary*, 552 F.3d at 1380. Courts compare Plaintiffs' purported chain of causation theory against what actually set the chain into motion; if the occurrence that actually set the chain in motion occurred between the agency action and end result, the causation chain has been broken. *Id.* at 1378-79 (Plaintiffs alleged Forest Service Policy caused wildfire, but court found that a hunter igniting the fire was an intervening cause that broke the purported chain of causation); *Thune*, 41 Fed. Cl. at 53-54 (though government ignited forest fire, wind changes were the intervening cause of it burning plaintiffs' property). Further, an injury is not the direct, natural, and probable cause of a government action if "[o]nly by an intervening cause was the authorized action converted into a damaging event." *Cary*, 552 F.3d at 1378–79; *Moden*, 404 F.3d at 1344-45.

19. Severity and Duration of Flooding

As the Federal Circuit explained, "government interference with property rights that is not substantial and frequent enough to rise to the level of a taking" is a tort, and not compensable in this Court. *Ridge Line*, 346 F.3d at 1355. Once courts determine the amount of an intrusion is attributable to a government action, they discern how that amount compares to rest of the intrusion and the consequences of that additional amount. *Ark. Game & Fish (III)*, 736 F.3d at 1375. Put differently, the question is not simply whether Plaintiffs experience—for example—longer, or more severe flooding now compared to before the agency action that changes the character of the use of the land, but rather, how much—if any—of the increase is caused by the agency action, and whether that amount, relative to the other causes, results in a taking. *Alost v. United States*, 73 Fed. Cl. 480, 494 (Fed. Cl. 2006). Courts also consider the context surrounding the severity and duration of an intrusion to determine if it is a taking, such as whether it the intrusion is unprecedented and directly caused by the agency action; whether the

"intrusion was within a range that the property owner could have reasonably expected to experience in the natural course of things[,]" or whether even a significant incremental effect due to government intrusion becomes inconsequential when it only occurs "in connection with a truly major flood event." *Id*; *Leeth*, 22 Cl. Ct. at 487. For example, when natural flooding will last a large number of days and be at depths that would already cause damage—such as destroying crops—the addition of an incremental length of days of flooding or depth due to government action is unlikely to "materially enhance" the damage caused by the flood and result in a taking. *Leeth*, 22 Cl. Ct. at 467–488; *Bartz*, 224 Ct. Cl. at 577.

To assess the effect of government action on an owner's property, the courts must first identify "the relevant mass of property" against which to measure the impact of the government action. *See Keystone Bituminous Coal Ass'n v. DeBenedictis*, 480 U.S. 470, 500 (1987) (outlining the "parcel as a whole" test). If the Court were to determine that any minor increase in water surface elevation could potentially arise to the level of a taking, the Court would need first to determine the relevant parcel as a whole, and evaluate the severity and duration of increased flooding in the context of each Plaintiffs' relevant property interest. This is because Plaintiffs have not alleged, nor can they show that there has been a permanent physical occupation of their property or a complete seizure of a portion of their properties. Indeed, most plaintiffs have continued to use their properties for productive farming in years after the flooding alleged. *See* Tables 3-7 at Column I (listing post-2004 years of productive use).

20. Expert Testimony

Corps' changes to reservoir operations and habitat construction did not cause the flooding alleged, and that Plaintiffs' experts methods do not accurately evaluate the effect of Corps' changes, and therefore their conclusions are unreliable.

a. Dr. Mussetter's Opinions Show Habitat Projects Did Not Increase Flooding.

Dr. Robert Mussetter, an expert in sedimentation and hydraulic engineering, testified about the reliable industry-standard methodology he used to analyze data concerning the geometry of the river, including changes thereto, to conclude that the construction of habitat projects had little effect on water surface elevations. Dr. Mussetter's models and the data reflect that the river channel did not experience major change until the 2011 flood that caused widespread erosion and bed degradation regardless of Corps projects. Minor variations in sedimentation and channel geometry were overwhelmingly caused by natural processes unrelated to Corps projects. Tr. 10111:6-10112:24 (Mussetter).

Dr. Mussetter, a professional hydraulic engineer since 1983 who has over thirty-five years of practical professional experience in hydrology, geomorphology, and sediment transport, developed sediment transport and routing models using the industry-standard HEC-RAS software for other analyses comparing how cutting off bends or removing a dam would affect sedimentation. Tr. 9865:1-3968:18, 9870:4-9872:2, 9884:7-9886:8 (Mussetter), DX2072 (Mussetter CV). HEC-RAS is an open-source, well-documented model tested and validated thousands of times for engineering analyses, including sediment-transport and water surface elevation analysis.[65] Tr. 10239:19-10240:25 (Mussetter); Tr. 12836:17-20 (Kopania); Tr. 8785:4-24 (Shumate); Tr. 9616:4-9, 9494:20-25 (Bitner); Tr. 9269:1-19, 9287:7-9288:14 (Pridal); Tr. 4855:8-23 (Christensen).

i. Dr. Mussetter's Method Was Reliable and Effective to Determine Causation.

[65] The Hydrologic Engineer Center River Analysis System (HEC-RAS) model was developed by the Corps of Engineers and is publicly available for download and use. Tr. 8785:4-24 (Shumate); PX2215. It was adapted from a previous hydraulic UNET model that was based on floodplain mapping from the 1990s. Tr. 8780:24-8781:13 (Shumate).

Dr. Mussetter's reliably analyzed and quantified sediment and water surface elevations changes caused by the Corps. After touring the river twice, Dr. Mussetter created a reach-scale one-dimensional ("1-D") sediment transport model mathematically simulating flow and sediment transport that quantified impacts of post-2004 habitat projects on river bed and water surface elevations. Tr. 9881:11-9882:15, 10044:17-24 (Mussetter). It allowed him to isolate the impacts of project construction by holding all parameters constant other than the challenged action – here, project construction. Tr. 9882:16-9884:6, 10042:23-10043:9, 10044:17-10045:13, 10058:13-10059:2 (Mussetter). This method isolated the impacts of project construction from those attributable to variability in tributary flow and sediment, infrastructure, including levee construction, and instream sand and gravel mining. Tr. 9883:6-9884:6, 10109:21-10111:5, 10113:11-10115:20, 10064:2-24 (Mussetter). *See also* discussion *supra* Section II.4.b (discussing impacts of bed elevation from low-flow periods such as from 2001 to 2009), Tr. 10140:9-10142:6 (Mussetter), DX3014-11, DX3014-12, DX3014-13 (showing below-average flows). Importantly, Dr. Hromadka and Dr. Christensen did not isolate effects caused by Corps actions from other effects, which is critical to answer questions of causation. Tr. 10142:7-10143:23 (Mussetter); Tr. 5540:9-5541:24 (Hromadka). Absent such analysis, it is impossible to determine what effect (if any) the Corps' construction activities had on water surface elevations.

Dr. Mussetter also created two-dimensional ("2-D") models to study with greater precision whether any adverse effects of Corps modifications occur due to changes in flow patterns (velocity and direction), depth, or water surfaces. Tr. 9889:23-9890:12, 9891:7-17, 9892:9-16, 10120:9-24 (Mussetter). He also used the 2-D model results to understand whether dike notches, in general, had sufficiently large impact on the conditions in the river to warrant explicitly including them in the 1-D model. Tr. 10043:19-10044:13 (Mussetter). *See* discussion

infra Section III.20.a.iv. Dr. Mussetter selected six sites that included varying projects, often with multiple different BSNP and off-channel modifications within the same reach.[66] Tr. 10088:8-10089:6, 10092:18-10093:13 (Mussetter). Dr. Mussetter created the 2-D model using the well-tested, widely-used SRH-2D software publically available and developed by the U.S. Bureau of Reclamation for sediment transport analysis. Tr. 9890:13-25 (Mussetter).

ii. Dr. Mussetter's Models Conservatively Accounted for All Sediment Contribution from Corps Activities.

In order to determine whether any of the minor bed aggradation or degradation was attributable to Corps activities, Dr. Mussetter's models included sediment deposited from natural processes (natural bank erosion and tributary flow) and sediment contributed from Corps habitat construction.[67] Tr. 9991:10-9992:8, 9992:23-9993:8, 9994:6-16 (Mussetter). For sediment inputs related to Corps activity, Dr. Mussetter included amounts from the dredging or excavation (both in-channel and off-channel), from chute widening, and from bank erosion at locations with and without BSNP modifications. Tr. 9993:9-9994:2, 9996:9-23 (Mussetter). *See also* DX0225 (quantifying excavation volumes). The data showed that, for all particle sizes, Corps habitat construction contributed only 15% of the total sediment input from 2004 through 2012; for sand input, Corps projects made up approximately 8% of the total. Tr. 10021:14-10022:21, 10024:2-22 (Mussetter); DX3014-95, 3014-97. Dr. Mussetter's approach conservatively treated all of the sediment as sand for his 1-D model, which overstates project effects because collected sediment

[66] The six 2-D models included Decatur Bend (RM 677.5 – 692.5), Desoto Bend (RM 641.7-646.1), Hamburg Bend (RM 544.1-556.7), Rush Bottom Bend (RM 505.5-498), Wolf Creek Bend (RM 477-483), and Worthwine Island (RM 455-460). Tr. 10092:11-17 (Mussetter), DX3014-136.

[67] The data came from the West erosion study and from good-quality USGS measured tributary suspended sediment and bed material data. Tr. 9997:20-9998:22, 10001:16-10002:4, 10002:15-21, 10003:24-10004:2, 10005:7-23, 10010:17-10011:12 (Mussetter). Where a given tributary lacked a sediment gage, Dr. Mussetter applied industry standard methods using available data to estimate ungaged sediment loads. Tr. 10008:17-10009:17 (Mussetter), DX3014-83.

samples often had high silt/clay amounts that are more likely to be carried downstream than to aggrade the bed. Tr. 10025:21-10026:15, 10028:11-23, 10030:12-10031:7, 10033:19-10035:5 (Mussetter); Tr. 9582:17-9583:20, 9583:24-9584:9 (Bitner); DX0286; DX0576; DX3014-100. This data illustrates the folly in Plaintiffs' experts' methods—assuming all aggradation or degradation after 2004 resulted from Corps habitat projects though sediment input from Corps activities is only a fraction. This folly is exacerbated because there were low-flow periods following 2004. *See* Section II.4.b (describing *natural* aggradation during low flow periods).

Dr. Mussetter used other conservative assumptions that likely over-estimated any adverse effects of habitat projects, so where there is a discernible change in bed or water surface elevations, the change attributable to Corps actions would be less. Tr. 10066:9-25 (Mussetter). For the 1-D model, Dr. Mussetter assumed that all sediment from chute widening stayed in the river, including that from the 2011 flood that likely was deposited elsewhere on the floodplain. Tr. 10020:6-10021:4 (Mussetter). Dr. Mussetter's 2-D models only represent overland not groundwater flow, so low-lying land shown as dry were likely wet sooner from groundwater; the models thus overstate water level differences at low flows. Tr. 10091:2-10092:4, 10180:17-10181:25, 10173:6-15 (Mussetter); DX3014-202.[68] The multiple conservative assumptions mean that actual changes attributable to Corps' actions are less than modeled changes.

iii. Dr. Mussetter's Models Were Calibrated, Validated, and Compared to Plaintiff Descriptions of Flooding to Confirm Accuracy.

Dr. Mussetter's models were calibrated and validated, based on data, to ensure the results were reliable. Tr. 10042:6-12. 10050:2-11 (Mussetter). With respect to geometry, the models

[68] For example, the Rush Bottom Bend chute is riverward of two natural remnant chutes (i.e., low-lying areas) that accumulate water before the river level exceeds the channel, but the model does not show that early natural inundation. Tr. 10180:17-10181:25 (Mussetter); Tr. 9675:9-25, 9678:4-8, 9679:3-18 (Bitner); DX3014-202.

used the best-available bathymetric (river bed and channel geometry) data from before and after habitat construction. Tr. 10047:5-10049:11 (Mussetter); DX3014-11. The 1-D hydraulic model calibration against USGS rating curve data showed high correlation. Tr. 10050:25-10051:16, 10641:2-22, 10643:11-10644:11 (Mussetter); DX3014-112, 3014-344. Dr. Mussetter calibrated the sediment transport aspects of the 1-D model by comparing the computed to measured sediment loads and bed changes and validated that against a separate data set for later years. Tr. 10052:9-10053:16, 10056:22-10059:2 (Mussetter); DX3014-114. The 2-D models were also calibrated and validated.[69] Tr. 10094:20-24, 10050:12-21, 10115:5-20, 10118:23-10119:20 (Mussetter). Once calibrated, the only parameters adjusted concerned the Corps actions alleged, so Dr. Mussetter's model can accurately assess what river changes are attributable to Corps habitat activities. Tr. 10639:5-16, 10118:13-22 (Mussetter).

iv. Dr. Mussetter's Models Projected no significant negative impact on water-surface elevations from habitat project construction.

From the 2-D models, Dr. Mussetter concluded there was no significant impact to water surface elevations from Corps habitat projects. Tr. 10105:3-15, 10128:1-6, 10175:1-21, 10195:15-22, 10225:1-11, 10232:1-25 (Mussetter). Each model isolates and quantifies potential impacts of chutes, BSNP notches and extensions, reverse sills, and chevrons—allowing him to reliably conclude that Corps activities had no impact on Plaintiff properties.

The fifteen-mile Decatur Bend model included the Middle and Lower Decatur chutes, dike notches and extensions, and a revetment lowering. The results show virtually no difference in water surface elevations with and without these features (maximum increase less than one

[69] As an example, Dr. Mussetter compared modeled levee overtopping to reports thereof to confirm model accuracy. Tr. 10200:18-10201:21 (Mussetter); DX3014-238, 3014-239.

inch).[70] Tr. 10100:23-10101:20 (comparing dashed and solid lines), 10103:10-24 (Mussetter); DX3014-145, 3014-146; Tr. 10095:16-10096:21 (Mussetter); DX 3014-140; *see also (*Tr. 10870:14-10872:15, 24-25 (Woodbury) (describing that chutes do not increase water surface elevations for a given discharge on the River, because the chutes provide additional area or increase the conveyance). The results are consistent with measured bed data that do reflect some aggradation of the river bed in the channel nearest the revetment lowering (RM 686), but degradation elsewhere and no loss in channel capacity. Tr. 10098:17-10100:22, 10102:5-10103:9, 10104:23- 10105:15 (Mussetter); DX 3014-143, 3014-144.

The four-mile Desoto Bend model includes dike notches, reverse sills, chevrons, and revetment notches, and showed a slight rise of approximately 4 inches in water surface elevations for flows up to 75,000 cfs with the shallow water habitat in place, with effects decreasing with distance upstream. Tr. 10105:19-10106:22, 10121:3-10 (Mussetter). But, this minimal projected increase due to the chevrons, would likely be less for flood flows that spread out once above the channel, and because the model does not account for likely scouring. Tr. 10122:11-10124:12, 10128:11-10129:2 (Mussetter); DX3014-155, 3014-156, 3014-157, 3014-158; *see also* Tr. 10868:20-10869:6, 10872:20-24 (Woodbury) (noting that control structures prevent sediment deposition).

Dr. Mussetter's modeling from the 13-mile Hamburg Bend model, examining dike notches, reverse sills, chevrons, the Lower Hamburg chute, and revetment notches showed that shallow water habitat features resulted in lower water surface elevations for the great majority of the reach, and any increases were less than 0.2 feet in magnitude over limited areas. Tr.

[70] The largest estimated increase, at only a small area, in water-surface elevations with-SWH was less than 0.05 ft (less than one inch) at very low flows, and less still at high flood flows. Almost all of the 15-mile reach modeled had the same or lower water surface elevations in the with-SWH scenario. Tr. 10100:23-10101:20, 10103:10-24 (Mussetter); DX3014-145, 3014-146,

10148:3-15, 10152:14-10153:24 (Mussetter); DX3014-173, 3014-174. Results tracked bed elevation data reflecting some sediment accumulation in the bed of the river, which was more than offset by the increase in conveyance from chute construction. Tr. 10174:20-10175:9 (Mussetter).

The Rush Bottom Bend and Worthwine Island (with notches) 2-D models indicated lower or identical water surface elevations. Tr. 10193:16-10194:23, 10195:7-22, 10225:14-10226:12, 10227:19-10228:21 (Mussetter); DX3014-226, 3014-227, 3014-228, 3014-262, 3014-267.

Dr. Mussetter also used the two-dimensional models to show local effects from notching to evaluate how he should account for notching in the larger one-dimensional model. Tr. 10195:23-10196:12, 10218:18-10219:13, 10043:19-10044:4 (Mussetter). At Wolf Creek, with dike and revetment modifications, the 2-D model showed that because of the increased conveyance capacity provided by the notches, the water surfaces were slightly lower almost everywhere within the 8-mile reach. Tr. 10199:19-10200:14, 10224:13-18, 10225:7-11 (Mussetter), DX3014-236, 3014-237. The few areas where higher water surface elevations were predicted were minor (i.e., less than 2.4 inches). DX 3014-237. Plaintiffs suggest that Dr. Mussetter's 1-D model should have physically represented each of the 7,000 individual dikes and notches over 400 miles, but the 2-D Wolf Creek (and other) models demonstrated the small, and generally positive effect the BSNP notches (even larger bank notches) had on overall channel velocity and water surface elevations. Tr. 10203:12-19, 10204:8-10208:4, 10209:16-21, 10215:7-23 (Mussetter); DX3014-246, 3014-247, 3014-248, 3014-250, 3014-252, 3014-254. This conclusion is expected given that removing material from the bank increases the cross-sectional area and conveyance capacity of the river. Tr. 10258:17-10259:16, 10261:13-25, 10263:2-10, 10263:15- (Mussetter); Tr. 9524:19-9525:12 (Bitner); DX3014-282, 3014-283.

Flow patterns with and without dike notches were similar except the notch allowed more downstream flow (and thus conveyance) that previously was blocked. Tr. 10216:20-10217:3, 10262:1-12 (Mussetter); DX3014-251, 3014-253, 3014-255. The features Plaintiffs' experts mischaracterize such as a downstream scour hole and eddy (circulating current) were present with and without notches, and any increased roughness in the channel bed from the notch is counteracted by the increased flow area through the notch. Tr. 10209:22-10211:3, 10224:19-10225:6 (Mussetter). Similarly, the sediment transport balance was very similar with and without shallow water habitats. Tr. 10220:2-10222:18, 10225:12-13 (Mussetter); DX3014-256, 3014-257, 3014-258.

Informed by the 2-D results, Dr. Mussetter used the 1-D model to determine whether changes to river geometry occurred anywhere along the River due to changes in reservoir operations, project construction, or both.[71] Isolating habitat construction impacts, modeled changes in river bed elevation were very similar with- and without- shallow water habitat projects, with minor aggradation only in a few areas. Tr. 10083:25-10084:22 (Mussetter); DX3014-129, 3014-130.[72] The greatest amount of predicted aggradation translates to less than 0.2 feet (2.4 inches) of difference in water surface elevations. Tr. 10084:23-10085:10 (Mussetter); DX3014-131. Considering the combined effects of shallow water habitat creation and reservoir changes for the same period through 2008, Dr. Mussetter found only a few areas showing close to one foot of aggradation in bed elevation, and this aggradation caused no more

[71] Dr. Mussetter's modeling was done iteratively in that he did not assume the initial model outputs were correct, but instead continued to calibrate both models and used the results from both to more accurately evaluate the river hydraulic and sediment-transport mechanisms. Tr. 10252:15-10254:20 (Mussetter). This iterative method is commonly used in the engineering field. Tr. 10254:18-20 (Mussetter).

[72] DX3014-129 shows the mean bed elevation with only SWH changes (green line) and with no changes (black line). The blue line on DX3014-130 shows the difference between the green and black lines from DX3014-129. Tr. 10084:7-20 (Mussetter).

than two inches of change in water surface elevations at the high flood flows, and lower elevations elsewhere. Tr. 10067:1-10070:11, 10080:6-10081:3, 10102:8-12 (Mussetter);[73] DX3014-117, 3014-118, 3014-123. Dr. Mussetter's conclusions were similar for the period from 1999 to 2012, in that the river bed experienced both aggradation and degradation, and maximum, conservatively-estimated changes to water surface elevations were less than four inches at low in-bank flows and less than two inches at high 10-year flows. Tr. 10081:4-10083:12 (Mussetter); DX3014-124, 3014-125, 3014-126, and 3014-127. For flows such as from the 2011 event, projected water surface elevations differences would be smaller. Tr. 10083:13-24 (Mussetter).

v. Dr. Mussetter's Results Are Consistent with the Undisputed Data and Plaintiffs' Criticisms Are Not Well-Founded.

Plaintiffs contend that Dr. Mussetter's conclusions are unreliable because he used models, which they suggest are inherently unreliable, yet they cannot identify a single data point that conflicts with Dr. Mussetter's conclusions. Dr. Mussetter's opinions are indeed consistent with bed elevation data, which showed only modest aggradation in some areas during low-flow periods and degradation after 2011. Tr. 10352:10-10353:11 (Mussetter). *See also* discussion *supra* Section II.4.d. Undisputed sediment load data from mainstem USGS gages exhibit equivalent or lower suspended and bed load rates during the period 2004-2015 than from 1976-2003. Tr. 10031:24-10033:12 (Mussetter); DX3014-101. Coupled with the fact that river bed changes since 2004 have shown the same general trends and variability as before 2004, the data demonstrate that new sediment added to the river from Corps habitat activities had no substantive effect on river behavior. Tr. 10348:23-10349:8, 10352:10-10353:11 (Mussetter).

[73] DX3014-117 shows the mean bed elevation with both reservoir and SWH changes (green line) and with no changes (black line). The blue line on DX3014-118 shows the difference between the green and black lines from DX3014-117. Tr. 10069:3-16 (Mussetter).

Gage data also shows no discernable trend in water surface elevations from 1998 to 2016 for flows within the channel; any variance is discernable only at flows outside the channel, where the water surface elevation is affected by many additional factors unrelated to in-channel processes, such as the location and height of levees and land use.[74] Tr. 9957:8-9958:16, 10184:9-10186:16, 10194:24-10195:22, 10349:9-18 (Mussetter), DX3014-45, 3014-46, 3014-207, 3014-208. *See also* DX0465, 0978, 1207-0016, 1214-0003. The evidence shows that Dr. Mussetter's conclusions are corroborated by measured data.

Plaintiffs pose hypothetical criticisms of Dr. Mussetter's work, but do not identify any data that contradicts his conclusions and do not identify the hypothetical impact on any legitimate criticisms. Plaintiffs claim the HEC-RAS model is unnecessarily complex and not useful, but the software provides good approximations of sediment-transport and hydraulic processes and is routinely used within the industry to analyze differences in river behavior between modeled scenarios. Tr. 10234:10-23, 10238:23-10241:2 (Mussetter); Tr. 4855:8-23 (Christensen) (agreeing it is deemed "state-of-the-art" and the "international standard."). Though models cannot have 100% accuracy, they are particularly useful for comparisons where all parameters are held constant except those being evaluated. Tr. 10235:22-10237:9 (Mussetter). The imperfection of models highlights the flaw in Dr. Christensen's approach that holds no parameters constant, and assumes that water surface elevations taken from the outdated Flow Frequency Study can be compared one-for-one to extrapolated gage results from 2007 to 2014. Tr. 10238:13-22 (Mussetter), Tr. 4752:22-4753:25 (Christensen). Plaintiffs' criticism that the large number of model inputs allows for inappropriate interference is also misplaced because Dr. Mussetter changed only parameters reflecting the changes alleged. Tr. 10242:24-10243:14,

[74] There have been changes to levee location and stability or height near the Rulo gage, including to the Holt 10 levee and private levees. *See* discussion *supra* Section II.14.d.

10244:16-10246:5 (Mussetter). Plaintiffs do not identify any specific parameters they believe were incorrect.

b. Changes to Reservoir Operations Did Not Materially Affect Flooding

i. Mr. Woodbury's opinions result from the application of reliable methodologies to reliable data.

Mark Woodbury, Director of Water Resources Operational System Center at RTI International, has over a quarter-century experience in reservoir management and operations, modeling, river forecasting, meteorological, hydrologic and hydraulic analyses on river systems around the world. Tr. 10739:18-22, 10741:25--10745:6, 10746:11-17, 10746:23-10748:7, 10749:10-10750:14 (Woodbury). He investigated and quantified the impact of changes in Missouri River operations associated with revisions to the Master Manual and construction of habitat projects. Tr. 10738:18-10739:2, 10752:18-10753:16 (Woodbury). He determined that the fundamental causes of alleged flooding were precipitation, snowmelt, and the consequent runoff into streams, rivers, and reservoirs. Tr. 10784:4-9. (Woodbury).

ii. Mr. Woodbury's Method Was Reliable and Effective to Determine Causation.

Mr. Woodbury developed a reservoir model and a hydraulic model to determine the impacts of the Corps' changes. Tr. 10807:8-9 (Woodbury), DX 3015-14. He did this by reviewing necessary data, calibrating the models to observations by making adjustments to the model to reflect what actually happened, and then changing model parameters to reflect water surfaces with and without the Corps changes. Tr. 10755:6-22 (Woodbury).

Mr. Woodbury's model used relevant reliable data. For the modeling inputs, Mr. Woodbury used historical data collected by many federal agencies, states and internet sources, such as topographic, bathymetric, tributary flows, and runoff to the reservoir system, to take

snapshots at fixed points in time before and after the Corps changes to route water[75] from the reservoir simulations to calculate in great detail differences in water surfaces that could be expected under different conditions. Tr. 10753:2-10754:19; 19755:22; 10756:3-10; Tr. 10756:17-10757:1; 10758:24-10759:21 (Woodbury). Mr. Woodbury describes the data used to generate these snapshots as better historical data than most anyplace else he has modeled over the course of his years of experience. Tr. 10767:18-21, 10853:17-24 (Woodbury).

For the reservoir model, Mr. Woodbury used the Corps' 2006 HEC-ResSim model to simulate the System under actual and hypothetical conditions. Tr. 10814:3-10815:8, 10816:21-10817:4 (Woodbury). The ResSim model calculates System storage, determines water supply tributary storage, calculates the service level, determines the minimum release and the allowable reductions to accommodate downstream inflows. Tr. 10823:10-10825:22 (Woodbury).

The parameters (i.e. rules) of the reservoir model include the reservoir characteristics, the river system configuration, and the operating rules and constraints set forth in the varying editions of the Master Manual. Tr. 10763:24-10764:1 (Woodbury), 10770:16-10771:3 (Woodbury); s*ee* DX 3015-14. Inputs to the reservoir model included data of upstream inflows to the System, tributary inflows up and downstream, evaporation, precipitation and existing snowpack forecasts. Tr. 10771:4-18 (Woodbury). Mr. Woodbury used the reservoir model, once calibrated, to run two simulations from 2006 through 2014 to predict the reservoir releases based on reservoir operations under a strict reading of the 1979 ("no MMR") and 2006 Master Manual ("MMR") with no discretion. Tr. 10772:15-10773:12, 10774:6-8, 10776:16-18 (Woodbury).

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[75] One difference between Mr. Woodbury's model and Dr. Christensen's is that Mr. Woodbury's actually routes flows downstream through sequential river cross-sections based on the topography of the river. This allows him to input tributary flows where they join the mainstem. In contrast, Dr. Christensen only interpolated water surfaces between the nearest up and downstream gage, regardless of where any tributaries or topographical changes are between the gages. His method would not, therefore, reflect localized effects. Tr. 8427:1-8429:19 (Remus).

The comparison of results from these two simulations are the impacts exclusively due to Manual revisions. Tr. 10773:13-15 (Woodbury). Mr. Woodbury then compared the results of each simulation against the observed reservoir releases actually made by the Corps. Tr. 10773:13-17 (Woodbury). Because the Corps has information not available to a modeler as well as discretion in some of its releases, actual operations at times vary from strict Manual operations. For example, navigation releases may depend on the presence of boat traffic, ice conditions may affect releases, and during the 2011 flood, release decisions were made to ensure levee stability. Tr. 10773:15-10776:18; 10827:7-10829:16 (Woodbury). The outputs from the reservoir model served as inputs to the hydraulic model. Tr. 10771:19-24 (Woodbury); s*ee* DX 3015-14.

The second model, a hydraulic HEC-RAS model,[76] simulated and evaluated water surface elevations based on downstream runoff, actual and hypothetical reservoir releases, and actual and hypothetical channel and overbank configurations over time.[77] Tr. 10777:15-21, 10778:22-23, 10854:10-13 (Woodbury); DX3015-11. The model routes reservoir flow through a series of cross-sections based on the topography of the channel and surrounding land and computes differences in water surface elevation between cross-sections. This allowed Mr. Woodbury to ascertain the stage at each property over time (a hydrograph). Tr. 10766:11-16, 10778:12-10780:22 (Woodbury), DX3015-17. There were two alternative channel configurations for each time period: one reflected river topography without post-2004 SWH projects ("No-SWH"), and the second alternative reflects the geometry of the river before the year 2000 ("pre-2000"). Tr. 10777:22-10778:6, 10854:19-24 (Woodbury).

[76] Mr. Woodbury has extensive experience with HEC-RAS, an international standard model. Tr. 10739:23-10740:1, 10745:7-14, 10746:11-22 (Woodbury). *See* discussion *supra* § III.20.a.
[77] Additional inputs included topographic data for the channel and overbank, USGS stage and discharge measurements, and SWH construction details. Tr. 10852:24-10854:3, 10903:1-16 (Woodbury), DX3015-76, DX3015-77, and DX3015-111.

Mr. Woodbury calibrated both models using test runs to compare simulation results against observed data, which here was principally measured elevations at stream gages. Tr. 10755:6-13, 10760:9-20, 10766:19-10767:5, 1077:18-21, 10781:22-25, 10891:14-16, 10897:15-10899:3, 10918:9-10919:8, 10921:1-4 (Woodbury), DX3015:119. These calibration efforts, were done for each year to best approximate conditions and to assure reliability with respect to causation. Tr. 10760:21-10761:22, 10919:11-24 (Woodbury), DX3015-120. This extensive calibration effort meant Mr. Woodbury had confidence in modeled comparisons of stage differences. Tr. 10939:1-8 (Woodbury).

The combined results of the three different flow conditions from the reservoir model (actual reservoir releases, releases under the 1979 Master Manual ("no MMR"), and releases under the 2006 Master Manual ("MMR")) and the two different river geometries from the hydraulic model(baseline or actual geometry, "no-SWH," and "pre-2000") are shown below. Tr. 10778:7-10779:22 (Woodbury), DX3015-17

		Flow Condition		
		Actual	MMR	No-MMR
Geometry	Baseline	Baseline/Actual	Baseline/MMR	
	No-SWH			No-SWH / No-MMR
	Pre-2000			Pre-2000 / No-MMR

Mr. Woodbury then used the four combined reservoir/geometry scenarios to assess and quantify the impact of reservoir operational and channel SWH modifications. Tr. 10752:18-10753:16 (Woodbury). The methodology roadmap approach used by Mr. Woodbury is repeatable and replicable. Tr. 10755:18-21 (Woodbury).

iii. Changes to Reservoir Operations Have Been Minor and Did Not Materially

Affect Flooding.

Mr. Woodbury testified to the practical limitations of regulation of the Mainstem Reservoir System. They include the available storage in total, the importance and challenges of calculating lead time associated with reservoir releases and the possible impact on locations along the River based on when and where rainfall occurs, trade-offs between upstream and downstream flood sources depending on the timing of each, the location of the reservoirs versus the location of the inflows, and minimum flow requirements to support the authorized purposes of navigation and water supply. Tr. 10810:18-10813:19 (Woodbury), DX3015-46. Mr. Woodbury reads the 2006 Manual to prescribe five operational changes: the spring pulse, navigation service level and season length, increased minimum winter releases, unbalancing of the three upper reservoirs, and adaptive management. Tr. 10831:23-10832:4 (Woodbury). Mr. Woodbury found no impacts to flooding from to the spring pulse releases and that minor changes due to increased winter releases had no impact on flooding. Tr. 10839:8-10840:21, 10843:12-18 (Woodbury); DX3015-61; DX3015-62. The Corps has not unbalanced the reservoirs and therefore there has been no impact, nor did Mr. Woodbury find any change in actual operations reflective of adaptive management. Tr. 10843:24-10845:8, 10845:10-10846:10 (Woodbury). Changes to the variable navigation season were only potentially a factor in 2010 when a high-runoff year followed the year after a drought during which more water had been stored in the reservoirs. To assess any impact on the representative properties, one must consider the hydraulic modeling results, described below . Tr. 10841:21-10843:10 (Woodbury).

In sum, Mr. Woodbury found, based on the comparisons between the simulation and actual releases, that changes in Corps operational policies have been minor, were concentrated in periods of drought, resulted in no discernible change in releases during floods, and that, on

balance, the Corps' actual operations under the 2006 Manual had more reductions in releases than increases in releases during periods of flooding. Tr. 10847:10-16, 20-23 (Woodbury).

From this, he concluded that the changes in the Corps' operational policy changes have not impacted flooding. Mr. Woodbury's conclusions are validated by his comparison of the text from the 1979 and 2006 Manuals concerning the priority of flood control which reflects a consistent balancing of priorities, and similar flood operations. Tr. 10848:17-10849:16 (Woodbury). Mr. Woodbury's models effectively quantify the change in releases that arose from the revisions to the Master Manual. Tr. 10849:14-16 (Woodbury).

iv. Channel modifications for the purpose of establishing SWH have been minor.

The impact of the Corps' SWH is captured in the various geometry profiles used in for Mr. Woodbury's hydraulic modeling. Tr. 108735:23-25 (Woodbury). Under his "No-SWH" geometry, the Corps' SWH features are removed, but it does not account for whatever impact SWH sediment deposits have on water surface elevations.[78] The "Pre-2000" geometry does not reflect natural sediment aggradation after 2000, so it would tend to overstate effects from Corps habitat projects. Thus, the actual impact of the Corps' mitigation activities is between the "No-SWH" (red line) and the "pre-2000" (grey line) scenarios. Tr. 10887:22-10889:6 (Woodbury).

Mr. Woodbury's results comparing water surface elevations with and without SWH showed, consistent with Dr. Mussetter's analysis, little effect because the chutes generally increased the conveyance of the channel. Tr. 10870:14-10872:15, 24-25 (Woodbury), DX3015-90. For BSNP modifications, Mr. Woodbury relied upon Dr. Mussetter's analysis and Corps historic reports reflecting that dike notches preserved, rather than impeded, channel conveyance.

[78] As described above, Dr. Mussetter's findings show little if any negative impact to water surface elevations from sediment deposition. *See* discussion *supra* § III.20.a.iii.

Tr. 10877:24-10878:10, 10879:2-12 (Woodbury); DX3015-98. His own comparison of bathymetric data, which would capture cumulative sedimentation impacts over time, also confirmed the negligible impact of dike notching and no resultant sediment buildup. Tr. 10881:19-10884:22 (Woodbury), DX3015-100.

v. Similar flooding would have occurred Absent Corps Changes.

Mr. Woodbury conducted detailed analyses of flooding at each representative property for each year claimed, and his modeling demonstrated that the flooding would have occurred in the absence of the Corps changes. Tr. 10782:18-25 (Woodbury). In arriving at his opinion, he also considered the general characteristics, size, location, map of the property, description of flooding, and precipitation gages near the property. He used these to create a hydraulic model cross-section reflecting channel and property topography and characteristics, then used digital elevation maps to determine the overbank and drainage elevations that were then plotted on the hydrographs for each property for each year flooding was claimed.[79] Tr. 10994:14-10997:6, 11000:19-25 (Woodbury), DX3015-171, 172, 174, 175, 177, 181. He also used aerial and satellite imagery close to the time of the flooding, and performed inundation mapping to confirm the incidence of flooding. Tr. 10999:8-15 (Woodbury), DX3015-178 and DX3015-179.

Mr. Woodbury plotted his hydraulic modeling results in a hydrograph and table containing four scenarios: baseline/actual (blue line), baseline/MMR (green line), no SWH/no MMR (red line), and pre-2000/no MMR (grey line).[80] Tr. 11001:5-24 (Woodbury). The

[79] Neither Dr. Christensen nor Dr. Hromadka identified an elevation at which either overbank or drainage/seepage flooding would occur at plaintiff properties. Tr. 5632:22-5633:17 (Hromadka). This means they are unable to determine when flooding began and ended; their results do not allow them to determine whether flooding would have taken place absent the Corps changes – only that flooding took place. This weakness renders their opinions unhelpful to determination of but-for causation.

[80] The first term in the scenario represents the geometry and the second term represents the

accompanying Table 8 compares the difference in peak stage and the duration of the water surface elevation above the impact elevation (overbank or drainage).[81] Tr. 11029:22-11033:10, 11036:23-11038:18 (Woodbury), DX3015-183. Plaintiffs did not attempt to assess the overbank or drainage elevation to quantify either the water surface elevation differences in terms of or duration of flooding. Tr. 11041:8-14 (Woodbury); Tr. 5632:22-5633:17 (Hromadka).

Mr. Woodbury prepared summary tables for each flood claim with a hydrograph and comparisons of differences in peak stage and the duration water was above the impact elevation (overbank or drainage). *See* DX3015-620 to DX3015-637. Mr. Woodbury's results show that the peak stage differences are small, often on the order of inches, and that the duration of above-impact elevation flows are similar comparing operations before and after Corps changes.[82] *See, e.g.*, Tr. 11258:16-11264:18 (Woodbury).

Mr. Woodbury also concluded that precipitation, snowmelt and consequent runoff were the fundamental causes of the flooding from 2007 to 2014. Tr. 10784:4-9 (Woodbury). The period of flooding followed an eight-year drought in the upper basin, and consecutive years of above-average runoff refilled the reservoir system by 2009, with the years 2011 and 2010 generating the first and third highest runoff in the last 65 years at St. Joseph and NOAA precipitation maps showing much above normal and record wettest rainfalls in many locations in the basin. Tr. 10806:8-18 (Woodbury). *See also* discussion § II.15.c-d. In 2007, 2008, 2013

release scenario from the reservoir modeling. Tr. 11024:3-21 (Woodbury).

[81] At trial, the positive numbers signified a higher stage in feet and a longer duration when compared to the baseline/actual (blue line) plot (and negative numbers the opposite). Tr. 11030:22-11033:10, 11036:23-11038:18 (Woodbury); DX3015-183. Because Dr. Schaefer used the opposite numbering convention and eliminate confusion, the United States has reversed Mr. Woodbury's negative and positive numbers in Table 8 to show positive numbers where there was a higher water level or longer duration of flooding than would have occurred absent Corps changes; negative numbers on Table 8 indicate there was less flooding than would have occurred without the changes.

[82] One instance of dissimilarity is the duration of 2011 flows. *See* Tr. 10828:18-24 (Woodbury).

and 2014 especially, there were low reservoir releases; but, heavy rains in the lower basin meant the System had a limited ability to minimize flooding farther downstream. Tr. 10789:4-10792:8 (Woodbury), DX3015-25, DX3015-26. Other than 2011, flows from Gavins Point constituted less than 25 percent of the total peak flow downstream of Nebraska City. Tr. 10988:14-19 (Woodbury). Corps attempts to minimize peak flows from tributary and local inflow by cutting back releases during peak events were evident from release data. Tr. 10988:20-23 (Woodbury). Mr. Woodbury's analysis of regional rainfall reflected precipitation highs in many months and locations from 2007 to 2014. Tr. 10794:8-10799:25 (Woodbury), DX3015-28 to DX3015-34. With respect to local precipitation, heavy rainfall often caused or contributed to blocked drainage.[83] Tr. 10800:1-10801:22, 10804:2-4, 9-12 (Woodbury), DX3015-36.

vi. 2011 Flooding Was Not Caused By the Corps, but Instead A Combination of Extreme Weather Events.

The extreme weather in 2011 mandated record releases from Corps reservoirs. *See* discussion *supra* § II.15.d. But, flood control was the primary focus of reservoir operations, and because there we no changes in flood control procedures between Manuals, there was very minimal difference in releases in 2011. Tr. 10838:7-15 (Woodbury). Water supply forecasts under-predicted runoff from January through April and actual inflow in the System from May 2011 was approximately double the forecasts. Tr. 11373:24-11374:4 (Woodbury). Then, given how late in the season runoff entered the System, record 160,000 cfs releases were required to evacuate the record-setting runoff. Tr. 11374:9-21 (Woodbury); Tr. 7392:13-15 (Farhat). A Corps model simulation, reviewed and confirmed by an independent expert panel following the

[83] At the George Neale Farm, there 9-10.5 inches of rain fell within days in May 2007, which exceeded the 90th percentile for that month. Tr. 10802:6-10804:2 (Woodbury), DX3015-37. At the Green property, there was three inches of rain on a single day in June 2015 and resultant significant ponding. Tr. 10804:13-10805:8 (Woodbury).

2011 flood, demonstrated that even if the Corps had an additional 4.6 MAF of flood control storage available at the start of the 2011 runoff season, peak releases could have been reduced only to 100,000 cfs and would have lasted through November.[84] Tr. 13677:9-23 (Grigg); DX0192-0083. In 2011 releases were reduced from record levels as soon as feasible, but due to concerns with impacts to banklines after such high flows, releases were reduced incrementally rather than all at once. Tr. 10828:16-24 (Woodbury).

Plaintiffs' claim that the less-pervasive flooding in 1997 despite high runoff demonstrates that Manual changes affected flood control operations, but Mr. Woodbury's comparison of the 2011 and 1997 weather shows that differences in reservoir operations resulted from differences in timing of runoff and water supply forecasts. Tr. 11373:6-15 (Woodbury); Tr. 4591:21-4592:3; 4595:5-8; 4598:1-4 (Christensen). In 1997, because the prior year's runoff was not completely evacuated by the start of the runoff season, less designated flood storage capacity of the reservoirs was not available.[85] Tr. 7098:19-7099:3; 7392:1-3; 7501:2-17 (Farhat). In addition, runoff came far earlier in 1997; the January through May monthly water supply forecasts were consistently higher in 1997, triggering earlier releases. Tr. 11373:16-23 (Woodbury); Tr. 7393:10-17; 7394:1-12; 7395:9-19; 7399:2-13 (Farhat); DX 3001-202, -203, -204, -207. The 1997 releases earlier in the season and provided more time over the year to evacuate the runoff, resulting in lower overall release rates. Tr. 11374:15-21 (Woodbury). The Corps had no basis to make earlier releases in 2011 under either Manual. Tr. 11374:22-11375:11 (Woodbury).

vii. Dr. Christensen's analysis is flawed.

Dr. Christensen uses an over-simplified modeling approach, subjectively determines

[84] Previous record releases were 70,000 cfs. Tr. 7392:13-15 (Farhat).
[85] Existing storage is a factor in release decisions, so that less space available means earlier releases must be made. *See* discussion *supra* § II.2.b.

release modifications, confuses which releases are for habitat purposes, lowers reservoir releases beyond those used in the 2000s, and conflates service level with releases. Dr. Christensen used a computer spreadsheet that treated the six mainstem reservoirs like a single reservoir. Tr. 11355:21-11356:7; 11371:1-8 (Woodbury). His one-reservoir modeling allows water to be stored and released in a manner not possible given the configuration of storage in the System, and infrastructure limitations of each individual project. *Id.* As an example, for 2010, when heavy rains fell upstream of Gavins Point storage (with less than 1 percent of the System storage), Dr. Christensen assumed storage capacity was available that actually was not. *Id*.

Instead of using a computerized rule or algorithm that objectively reflects the rules of the Manual, Dr. Christensen deviates from the actual post-2006 operations – based solely on his concept of operational priority – in selectively and subjectively applying the 1979 Manual. Tr. 11356:18-11356:7 (Woodbury). An example of his subjectivity is his assumption that forecasted inflows would have, in fact, been available to support the release reductions that he subjectively determined should be made for flood control without verification that such information was available. Tr. 11357:1-4 (Woodbury). *See* Tr. 4552, 4553, 4943 (Christensen). Another example of subjectivity involved Dr. Christensen's determination that T&E releases in 2007, 2008, 2010, 2013, and 2014 coincided with high downstream flows. Tr. 11360:4-11 (Woodbury). But, in actuality, the 2007 bump in a Corps release was not a T&E release (Tr. 11361:10-11362:22, DX3015-645); the T&E releases in 2008 were immediately before and after the peak downstream flooding (Tr. 11360:14-17); in 2013, releases declined a full week before peak flooding in May showing prescience not otherwise foreseeable despite the Corps' nationwide policy to operate only for water on the ground and not for forecasted rain (Tr. 11362:23-11364:22 (Woodbury), DX3015-647); in 2014, Dr. Christensen both dropped the

releases earlier and deeper than the Corps did, showing prescience again, while at the same time violating minimum navigation targets multiple times at the Sioux City and Nebraska City gages. Tr. 11364:23-11366:4 (Woodbury); DX3015-648.

As another example of subjectivity, Dr. Christensen decided that the Corps would lower Gavins Point releases to 6,000 cfs, though 10,000 cfs was the then-current minimum flow because to water supply issues downstream. Tr. 11366:5-24 (Woodbury); 7209:11-7210:9 (Farhat). Dr. Christensen's too-low releases result in his overstating differences between the 1979 and 2006 Manual that are not evident nor intended by the text. Dr. Christensen's simulations also conflate service levels with releases, such that his "Old Policy" spreadsheet reflects releases of 29,000 cfs when the service level was 29,000cfs – regardless of tributary inflows. Tr. 11358:3-9 (Woodbury); Tr. 6937:8-14 (Farhat). These errors in Dr. Christensen's simulations result in a model which predict river flows and reservoir levels that could not exist in reality. Tr. 11371:15-11373:4 (Woodbury).

c. Dr. Christensen and Hromadka's Conclusions Regarding Channel Changes Are Unreliable.

Dr. Christensen and Dr. Hromadka's conclusions that project construction and reservoir operation updates changed the river are unreliable and either inconsistent with observed data or based on no data, and such theoretical untested hypotheses are insufficient to show causation. Tr. 10270:18-10271:8 (Mussetter). *See e.g. Laughlin*, 22 Cl. Ct. at 106 (rejecting expert analysis "based largely on projections, estimates, and assumptions."). Dr. Christensen hypothesized that creation of all of the SWH once contemplated would widen the river by 250 feet, making it shallower, slower, have higher roughness, and therefore less conveyance capacity. Tr. 10271:9-10272:8, 10278:7-12 (Mussetter), 4663:23-4664:7, 4668:21-4669:13 (Christensen). However,

the Corps has not constructed all the SWH contemplated,[86] the construction is done on isolated public land, and the data shows, except in a few isolated areas, the river has not widened as claimed, and especially not the navigation channel. Tr. 10211:4-10213:18, 10272:25-10273:11, 10276:11-10279:9, 10280:4-5, 10282:1-7 (Mussetter). In the few local areas where the channel did widen substantially as a result of Corps actions, the conveyance capacity and high-flow water surfaces have declined.[87] Tr. 10101:21-25 (Mussetter), DX3014-145, -147, -236, -237. Instead, the channel bed downcut significantly during the 2011 flood causing low-flow water surface elevations to decrease. Tr. 10281:4-13, 10281:23-10282:7, 10282:16-10283:21 (Mussetter), 10857:2-10858:16 (Woodbury). Both the Corps' pre-construction analysis, and Dr. Mussetter's post-construction analyses did not show a decrease in channel conveyance nor a corresponding increase in water surface elevations. Tr. 9272:10-9274:2 (Pridal), 10277:10-10278:16 (Mussetter).

Dr. Christensen then hypothesizes, without any data, that placement of a dike notch and excavation of a bank notch somehow cause sediment to fill the areas between dikes in the river. Tr. 4830:18-4831:9, 5004:11-5005:4 (Christensen) (describing that "whatever deposits there are," "it's got to be a substantial effect," without showing whether, where, or how much of any such deposits took place). Dr. Christensen's hypothesis is seemingly based on the notion that the creation of "shallow water habitat" means the river is becoming shallower, Tr. 4819:13-16 (Christensen), but he ignores that the notches either diversify flows in areas that were already shallow, or create new aquatic habitat in areas that previously conveyed little to no flow, and that

[86] The Corps initially underestimated the existing SWH present, and later more-precise techniques showed more. Tr. 9183:25-9186:1 (Chapman). This means less SWH had to be mechanically constructed to comply with the Biological Opinions.
[87] Localized to-width widening occurred at Three Rivers, Deer Island, Wolf Creek, and Decatur Bend. Tr. 9275:24-9276:7, 9626:4-10 (Bitner). *See* Table 1, MRRP Projects.

any claimed filling in the dike field would not affect water surface elevations during flooding as Plaintiffs claim. 9532:15-25 (Bitner), Tr. 9047:15-9048:9 (Chapman) Tr. 10263:15-10266:6, 10266:22-10267:19 (Mussetter), DX3014-284. Tr. (Mussetter). Dr. Hromadka similarly and improperly hypothesizes that Corps actions caused flooding because project construction could theoretically increase sedimentation and plaintiffs told him their properties flood more frequently than before 2004. Tr. 5094:6-5095:4 (Hromadka). His untested hypotheses are likewise insufficient to show causation. *See e.g. Laughlin*, 22 Cl. Ct. at 106; *Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997) (noting that court need not admit opinions connected to data only by the *ipse dixit* of the expert).

i. Dr. Christensen's Methodology to Assess Channel Changes Is Unreliable.

Dr. Christensen's method whereby he compared his predicted water surface elevations to USGS and Corps gage curves is unreliable because the gage curves were based on outdated data he improperly extended beyond pre-flood data, and the comparison does not account for the significant natural variability in the data, yet assumes that any variance from the outdated average was caused by Corps activities. Tr. 9901:1-9903:1, 10275:10276:10 (Mussetter). The many errors, detailed below, demonstrate that the opinions are unreliable, belied by data Dr. Christensen failed to consider, and merit no weight. Tr. 10315:25-10316:7, Tr. 10308:1-10309:4, 10315:21-24 (Mussetter).

First, Dr. Christensen ignores that rating curves are not precise expected water surface elevations but are instead best-fit averages reflecting data with great variability of up to three feet for a given flow both before and after the Corps changes. Tr. 10292:17-10293:6, 10300:5-17, 10302:16, 10316:8-15 (Mussetter), DX3014-300. Dr. Christensen then assumed any departure from the best-fit average reflected a change in the river caused by Corps actions, which ignores

the inherent variability of alluvial systems. Tr. 10311:15-10313:11 (Mussetter) (showing measured pre-2004 data both well above and below the best-fit “average” line). Second, the Corps 2003 UNET flow-frequency curves Dr. Christensen used at some locations were based on limited data at high flows, so cannot be reliably used as a basis to say that high-flow water elevations “changed.” Tr. 10294:9-25, 10300:18-22 (Mussetter). Third, the topographic data used to predict water levels went only through the mid-1990s so does not reflect changes that occurred in topography, levee heights, bed sedimentation, or other factors, which is a critical error given data and testimony confirming changes have been made to levees after the 1993 flood.[88] *See* discussion *supra* § II.14.c. Tr. 10295:5-14 (Mussetter), Tr. 8780:4-20, 8781:5-24 (Shumate).

Fourth and most problematic, Dr. Christensen assumes that any change between the observed flood levels and the gage curve’s average prediction is solely attributable to Corps actions alleged, without eliminating other potential causes of the changes. Tr. 10296:6-10297:1, 10298:18-10299:8, 10315:1-7 (Mussetter). Dr. Christensen’s failure to consider alternate causes for any differences between the flood elevations and the predicted gage curve elevations renders his opinions unreliable, and courts have often rejected expert conclusions for similar reasons. Tr. 10299:10-17 (Mussetter). *See e.g.*, *Laughlin*, 22 Cl. Ct. at 104 (rejecting expert analysis that “fails to break down the changes in elevation by year,” and “does not delineate the impact of [the dams] on natural river surface elevations” when variation was evident). Dr. Mussetter’s method, in contrast, did isolate and quantify effects of the Corps actions alleged. Tr. 9863:17-23, 9882:16-20, 9883:19-23, 10044:25-10045:6, 10084:25-10084:4, 10353:20-25, 10354:17-22 (Mussetter).

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[88] The Corps does not consider the stage trend profiles from the 2003 flow frequency study to be accurate today. Tr. 8782:12-8783:15 (Shumate).

Fifth, Dr. Christensen ignored that post-2004 flood levels were only higher than rating curve stages at very high flood flows and, lower at low flows;[89] this disparity is not consistent with his hypothesis that in-channel changes such as modifications to BSNP structures and creation of at- or below-bank chutes caused the differences claimed. Tr. 10306:8-10307:14, 10308:1-12, 10309:16-21, 10309:24-10310:12, 10314:16-20, 10317:11-10318:18 (Mussetter) (describing post-2004 green dots reflecting no change from the pre-2004 yellow dots at low flows below 150,000 cfs), 5021:21-5022:4, 5023:21-5024:2 (Christensen), DX3014-306, DX3014-308, DX3014-310, DX3014-314, PX2065. If the Corps' at or below-bank projects were changing water surface elevations, it would be most apparent during low flows; in contrast, changes to the overbank topography from heightened levees would only be reflected in elevations at high-flows. Tr. 12407:14-12408:10 (Schaefer), DX3018-364 (Tofani plot of Christensen data). Each of these errors in Dr. Christensen's methodology and reasoning demonstrate that his opinions are unreliable or belied by data he ignores. Tr. 10308:1-10309:4, 10315:21-10316:7 (Mussetter).

ii. Dr. Hromadka's Sediment Conclusions Are Inaccurate.

Dr. Hromadka's conclusion that there is significant channel aggradation attributable to Corps activities relies on data not specific to the years of Corps activity, is not specific to any plaintiff property, and does not reflect causation. Where the data showed aggradation, Dr. Hromadka presented reach-scale data from 1994 to 2013 or 2008 that does not segregate trends during dates of habitat construction (2004-2009). Tr. 9972:5-9973:16, 9987:3-12, 9988:21-25 (Mussetter), DX3014-55, DX3014-56, PX2153, PX2152. Because measurable channel aggradation occurred between 1994 and 1998 unrelated to Corps activities, Dr.

[89] In most areas, there is no measurable difference between scattered 2004-2011 and pre-2004 data points, until after the 2011 flood. Tr. 10306:8-10307:14, 10308:1-12 (Mussetter).

Hromadka's data set is not reliable to support the assertion that Corps changes caused the aggradation. Tr. 9987:13-9988:17, 9989:7-9990:5 (Mussetter), DX3014-66, -67, -69, -70, -72, -73, -75, -76. In other locations, the data shows no aggradation trend. Tr. 9973:17-9974:11 (Mussetter). For the few local areas analyzed, Dr. Hromadka's data set did not differentiate between aggradation of one or five feet, and the maps showed as much degradation as aggradation. Tr. 9975:1-9976:1, 9985:7-9986:16 (Mussetter), DX3014-57, DX3014-63, DX3014-64. Dr. Hromadka's limited data set cannot support his assertions of systemic aggradation over 800 miles of the channel, nor even at Plaintiffs' properties.

d. <u>The Corps Did not Cause Levee Breaches or Erosion.</u>

i. Dr. Schaefer's opinions result from the application of reliable methodologies to reliable data.

Jeffery Schaefer, Ph.D., an expert geotechnical engineer, testified about the reliable industry-standard methodology he used to analyze claims of erosion, seepage, and levee breaches to conclude that the Corps actions did not cause the flooding. Tr. 12219:21-12220:23 (Schaefer). Dr. Schaefer, a professional civil engineer since 1987, has 28 years of practical professional experience in geotechnical engineering, with significant experience performing levee breach analyses. Tr. 12206:6-12207:6, 12427:12-22 (Schaefer). He is the Lead Civil Engineer for the Corps of Engineers Institute for Water Resources Risk Management Center, a national center of expertise independent of Corps districts that provides technical advice, oversight, and review of projects including levee safety programs. As Lead Civil Engineer, Dr. Schaefer acts as a technical advisor for dam and levee projects, developing the risk analysis methodology for structure evaluation and has authored the geotechnical portions of dam and levee guidance documents. Tr. 12207:13-12209:1 (Schaefer). His professional experience includes levee design, construction and analysis of geotechnical risk and reliability, transient seepage analysis

and backwards erosion piping. Dr. Schaefer teaches classes on erosion, has published approximately 60 technical papers and given presentations with one on implications of sand boils for backward erosion piping risk. Tr. 12206:17-20, 12209:24-12212:1, 12429:5-7 (Schaefer).

ii. Dr. Schaefer's Methods Reliably Assess the Causes of Levee Breaches.

Dr. Schaefer used all existing data, considered the factors that can contribute to a breach, and are consistent with witness observations and two independent 2-D hydraulic analyses. For the federal levees, in addition to his own observations from a site visit, Dr. Schaefer collected and evaluated geotechnical reports including soil boring logs, chute design and construction drawings, seepage studies, levee performance and flood damage project information reports, and levee operation and maintenance manuals. Tr. 12213:22-24, 12214:9-17; 12215:10-15 (Schaefer). Additionally, he evaluated multiple hydraulic datasets, including hydrographs and bathymetry data, and two sets of 2-D modeling. Tr. 12214:19-25 (Schaefer).

Dr. Schaefer developed seepage models for the Upper Percival and Middle Hamburg breaches because he believed seepage might have contributed to the failures. Tr. 12217:10-12218:5 (Schaefer). The models incorporated soil boring showing variation in the thickness of the silt/clay blanket layer. Tr. 12349:5-12350:13 (Schaefer). Dr. Schaefer also confirmed model results were consistent with reality.[90] Tr. 12358:5-14 (Schaefer). Because plaintiffs claim that the Middle Hamburg chute contributed to the breach, Dr. Schaefer evaluated levee failure scenarios both with and without the chute in place, and with and without reservoir operation updates. Tr. 12354:22-12355:2 (Schaefer). The Middle Breach model accurately reflected pre-

[90] Dr. Schaefer's model originally used a 10 foot silt/clay blanket layer, based on averaging soil data. Tr. 12350:2-7 (Schaefer). However, when the early model did not match actual levee performance, he decreased the blanket layer thickness to make sure his model accurately reflected observed conditions and performance at the levee. Tr. 12356:6-12357:18, 12359:8-14 (Schaefer).

chute topography with an existing remnant river channel, at some areas between 8 and 16 feet deep, that was apparent in photos and design drawings. Tr. 12351:13-19, 12352:9-18 (Schaefer), 6142:4-6143:2 (Tofani), DX 576-00, DX896 at Plate B-3 (pdf p. 98), DX2049, DX3018-287, 3018-288.

For the L-550 levee, Dr. Schaefer qualitatively analyzed levee design data, photographs and eyewitness observations, and river hydraulics before and after the breach. Tr. 12217:10-12218:5 (Schaefer). For the non-federal and private levees, Dr. Schaefer had very little information available; in most cases, he had no specific date of the levee breach, which was necessary to determine the water levels and conditions at the time of breach. Tr. 12217:18-20, 12405:5-12406:6 (Schaefer). Although there was insufficient data to determine the exact cuase of the non-federal and private levee breaches, Dr. Schaefer's method was reliable to assess whether Corps changes caused the levee breaches.

Plaintiffs' few criticisms of Dr. Schaefer's breach methodology are not well-founded and reflect unfamiliarity with standard and accepted modeling techniques. Plaintiffs claim that Dr. Schaefer's relief well modeling depicts the wells as if they are continuous along the length of the levee. Tr. 6040:1-21 (Tofani). But that 2-D modeling technique, necessary for a non-3-D model and consistent with relief well design methods, uses the same well flow rate expected from actual relief well spacing. Tr. 12632:16-12633:20 (Schaefer). Plaintiffs also criticize Dr. Schaefer's use of a no-flow boundary at the far vertical landward edge of his model, but a no-flow boundary has no affect if placed – as Dr. Schaefer did – far enough away from the area of inquiry.[91] Tr.

[91] Plaintiffs provide no data or reasoning to suggest that, more than one mile from the property, more water would be flowing one way or the other, or that the use of the no-flow boundary affected Dr. Schaefer's modeling results, much less to their detriment.

12253:21-12254:23 (Schaefer) (describing a boundary more than one mile distant), 6036:7-16 (Tofani). [add more here]

iii. The Middle L-575 Breach Was Caused by a Piping Failure.

Dr. Schaefer concluded that the 2011 Middle Hamburg breach was caused by a piping failure precipitated by the formation of a scour hole, and that the breach would have occurred regardless of the alleged Corps changes. Tr. 12220:3-18 (Schaefer). The factors that contributed to the breach are the high magnitude and long duration flood flows, the narrowing of the floodplain width upstream, a kink point forming an angle in the levee that concentrates erosion, erosion of the silt/clay ground surface before and during the flood, levee placement over historic river meanders where the foundation material is more permeable, and relief wells that did not perform as designed during the flood because they were not properly maintained by the levee sponsor. Tr. 12391:25-12392:18 (Schaefer). A discussion of each of these factors follows.

First, the 2011 flood subjected the L-575 levee to flows of unprecedented magnitude and duration.[92] [93] Tr. 9353:18-9354:1 (Pridal). *See* discussion *supra* § II.15.d. Second, the distance

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[92] The 2011 flood was the first event since the dams closed when the flows at Nebraska City (RM 562.6 in the Omaha District) were higher than a 25-year flood level, and in 2011, there were 159 days of flood flows, which is more than double the most days of flooding experienced since at least 1930. Tr. 9354:10-9355:16 (Pridal), DX1070 at USACE4316385, Figure 3 (noting that the "2011 event dwarfs all other events which occurred on the historic Missouri River," and that the "event was unique in the historic record with excess floodplain energy at a very high level for a prolonged duration.") The high-magnitude flows also carried far less sediment than would be expected based on the historical record for flows of that magnitude, and therefore the sediment-starved water had higher energy available to erode material from the floodplain; the river then deposited high amounts of eroded sediment as flows and energy decreased toward the tail end of flooding. Tr. 9355:17-9358:6 (Pridal), DX 1070 at USACE4316387.

[93] Plaintiffs suggest that, because the levee had not breached since 1952, its failure in 2011 must be caused by a change in operations by the Corps, but this supposition, characteristic of *post hoc ergo propter hoc* reasoning, defies logic given the unprecedented nature of the flooding, and the fact that L-575 was estimated in 1984 to offer protection only from a 40-year flood rather than the 100-year flood designed at the time of construction. Tr. 8076:5-8077:14 (Remus), 12582:18-12583:13 (Schaefer).

between levees is narrower at the breach than upstream, creating a constriction in the floodplain. Tr. 12395:9-13 (Schaefer); 12140:17-23, 12141:20-24 (Flere); 5889:6-5890:1 (Tofani), DX3018-342, DX864, DX3017-113. Third, the alignment of the levee with a kink point jutting toward the river concentrated high velocities at that location. Tr. 12395:9-13 (Schaefer). *See* discussion *supra* § II.14.c. Both the two-dimensional modeling by Dr. Mussetter and ERDC showed parallel high-velocity flows concentrated at the kink point and breach location. Tr. 12381:13-12382:7, 12383:12-12384:8, (Schaefer), 9379:1-19 (Pridal), DX1088 at USACE8371473, DX3018-320.

Fourth, the 2011 flood eroded the silt/clay layer on the ground riverward of the levee breach, forming a large scour hole that allowed seepage beneath the levee and failure. Tr. 12364:19-24, 12356:22-12357:18, 12360:7-12362:3 (Schaefer), DX3018-296. To conclude that the scour hole caused piping failure, Dr. Schaefer used his model to calculate industry standard ratios predictive of failure, the potential for which increases when – as it was here —there is a thin silt/clay blanket layer. Tr. 12354:22-12356:5, 12355:18-5, 12365:1-22 (Schaefer), Tr. 12097:16-23 (Flere), DX3018-293, 5905:7-25 (Tofani).[94]

Fifth, the levee breached at a historic river meander of the Missouri River, an area typified by more erodible soils and a thinner blanket layer. Tr. 12222:22-25, 12350:15-18, 12392:8-11, 12357:12-18 (Schaefer), Tr. 8000:22-8001:3 (Remus), 12043:5-7, 12043:17-12044:10 (Flere). Historic documents depict the remnant river channel passing directly

[94] Mr. Tofani's original modeling results predicted failure under both the actual water levels and Dr. Christensen's level absent Master Manual updates, if the scour hole was present. Tr. 5904:15-5905:6, 5905:15-25 (Tofani), PX2664, PX2666, DX2050. At trial, though the ratios were the same, Mr. Tofani changed his opinion. Tr. 12365:1-13 (Schaefer), Tr. 5905:7-25 (Tofani), DX2051. He elected to disregard those results based upon non-quantified speculation that the scour would not have happened – even though a scour had developed nearby during the 1993 flood when the chute was not present. Tr. 5906:1-12 (Tofani).

underneath the L-575 Middle breach location. Tr. 12351:4-19 (Schaefer), Tr. 8002:10-8004:7, 8011:2-22 (Remus), DX1122 at US0010970-US0010971, DX3018-286. Contemporary photographs decades after the remnant channel was closed show dark areas indicative of a remnant channel. Tr. 12350:15-12351 (Schaefer), Tr. 12138:10-12139:9 (Flere), DX3018-285, DX735, DX3017-110. This evidence indicates the breach area was, since construction, susceptible to seepage problems. Sixth, the levee breached at a location where the landward relief wells – intended to alleviate uplift pressure that can contribute to levee failure – were not fully functional. Tr. 12230:1-12231:15 (Schaefer), 12095:11-25 (Flere), DX896 at § 6.3.2. *See* discussion *supra* § II.11.a.i. Dr. Schaefer's modeling results show that maintenance of the relief wells would have decreased the risk of failure. Tr. 12362:6-15, 12363:21-12364:9 (Schaefer)

iv. The Lower Hamburg Chute Did Not Contribute to the Levee Breach.

Dr. Schaefer determined that the Lower Hamburg chute did not contribute to the levee breach or create the scour hole by analyzing seepage, floodplain hydraulics, chute design information, and credible. With respect to seepage, both Mr. Tofani and Dr. Schaefer agree that any seepage from the chute was immaterial because the scour hole created a seepage entrance closer and deeper to the levee.[95] With respect to hydraulics, Dr. Schaefer analyzed the 2-D modeling from Dr. Mussetter and ERDC showing the chute did not direct flows toward the levee and that high-velocity flows were concentrated along the levee, as they were in previous floods. Tr. 12371:16-12372:12, 12381:13-12382:20, 12383:12-12385:7 (Schaefer), 10164:15-10165:6, (Mussetter), 9375:13-9376:3 (Pridal).

In addition to the hydraulic modeling analysis to determine that the Lower Hamburg chute did not contribute to the levee, Dr. Schaefer considered other evidence such as eyewitness

[95] The rates of seepage are determined by the closest seepage entrance. Tr. 12222:19-12223:8 (Schaefer).

accounts, and photographs. Tr. 12374:8-12376:15 (Schaefer). *See also* discussion § II.14.a.i (describing scour near the breach location before chute construction and elsewhere on L-575). Key to this analysis was the large scour holes elsewhere along L-575 and other levees with a similar alignment and no SWH projects were located. Tr. 12387:5-12389:11 (Schaefer). Applying similar reasoning as in *Loesch* demonstrates that numerous scour holes in similar locations elsewhere undermines Plaintiffs' claim here that the chute caused the scour hole. *Loesch*, 645 F.2d 914, n.8.

Plaintiffs offer no persuasive evidence suggesting the chute caused the scour hole to form. Tr. 6106:10-21 (Tofani). Mr. Tofani's seepage modeling did not consider any scenarios with the scour hole but without the chute, so his conclusion that the levee would not have breached but for the chute is baseless. Tr. 5913:16-5917:5 (Tofani), DX2048. Also, his modeling did not accurately reflect pre-chute topography, where there were depressions in the remnant river corridor before the chute was constructed, which farmers used as a drainage ditch. Tr. 12352:9-18 (Schaefer), 6145:3-23, 6148:16-6149:13, 6149:25-6150:9, 6154:2-10 (Tofani), DX576-0023, DX896 at Plate B-3 and B-17 (pdf p. 98, 112). *See* discussion *supra* § II. Some of pre-chute depressions extended below the excavated bottom of the chute, but Mr. Tofani's analysis did not account for any depressions. Tr. 12352:9-18 (Schaefer), 6145:3-12, 6145:19-23, 6147:2-4, 6147:12-15, 6149:5-6150:9 (Tofani).

In addition to the modeling errors, Mr. Tofani also ignored relevant evidence that discounts his conclusions. There was only one levee breach in the vicinity of a SWH and numerous levees that did not breach despite being loaded for months longer than L-575 and with the chutes far closer to the levee. Tr. 12391:10-15 (Schaefer) 9313:3-9314:14 (Pridal). Furthermore, the land riverward of the levee was inundated with eleven feet of water at the time

of breach, so the chute flows would have been indiscernible. Tr. 10160:15-10161:21 (Mussetter) (describing widespread inundation at flows below those at breach), 12353:24-12354:14, 12368:3-12370:4, 12370:9-12371:11 (Schaefer), DX 3018-304 (depicting water inundating the entire floodplain riverward of the levee). Mr. Tofani ignores that the chute widened, but did not migrate significantly closer to the levee even after the breach; so it was more than twice the minimum distance prescribed in the design reports and farther even than the 1,000-foot optimal setback distance from the river itself. Tr. 12352:19-12353:6, 12357:19-12358:4, 12367:1-15, 12371:6-8 (Schaefer), 6158:8-20 (Tofani). Finally, Mr. Tofani relied on self-serving descriptions of pre-breach flow direction that would violate hydraulic principles, if true; he also improperly gives weight on irrelevant observations well after the breach. Tr. 10162:15-10163:8 (Mussetter) 6174:16-24 (Tofani).

v. The L-575 Upper Breach Was Caused by a Piping Failure.

Dr. Schaefer concluded that the June 30, 2011 Upper Percival breach of the L-575 levee was caused by a piping failure precipitated by severe erosion to the river side face of the levee that would have occurred regardless of the alleged Corps changes, and the long duration high flows. Tr. 12398:13-24 (Schaefer). The upper breach occurred at a record water level and discharge for the river, and the water levelwas approximately the same as it would have been absent the Corps' changes. Tr. 12394:22-12395:13, 12395:21-12396:6 (Schaefer). The breach occurred at another kink point at an area likely overlying a remnant river channel. Tr. 12395:9-13, 12396:15-12397:5 (Schaefer), DX3018-345, DX3018-346. Further, a deep scour hole formed adjacent to the levee during the 2010 flood that the Corps had not finished repairing in advance of the 2011 flood. Tr. 12396:8-14, 12397:18-23 (Schaefer), DX3018-345, DX3018-347. Dr. Schaefer's seepage analysis showed that breach was likely because of the expanding

scour hole in place regardless of the Corps changes. Tr. 12397:8-16 (Schaefer). There is no constructed SWH near the levee breach, and no evidence the Corps caused or contributed to the breach. Tr. 12398:13-22 (Schaefer).

vi. The L-550 Levee Breached by Overtopping.

The L-550 levee breached after overtopping for several days in areas where no constructed shallow water habitats are present and at water levels that would have been similar absent any reservoir changes. Tr. 12403:25-12404:19 (Schaefer). The levee began overtopping at RM 537, several miles from the breach location, but no breach developed at that location. The breach developed at a location where the flood channel is constricted by the private L&H Investments levee directly on the opposite bank with no setback, where overtopping was observed. Tr. 12399:18-24, 12400:7-16 (Schaefer), DX3018-353, DX3018-354. The evidence confirms that the levee failure was not caused by any changes by the Corps.

vii. The Cause of the Many Non-Federal Levee Breaches Cannot Be Reliably Determined, and Is Irrelevant.

There are multiple potential causes of levee failure. Tr. 12095:11-12096:18 (Flere), 12405:21-12406:6 (Schaefer). During the 2007, 2008, 2010, and 2011 floods, there were private and non-federal PL 84-99 levee failures for which Plaintiffs provided little evidence to determine the cause of failure. In any event, none of the levee failures occurred in the vicinity of an MRRP project and the water levels absent Corps changes were very similar, so there is no basis to conclude that the levees would not have failed regardless of whatever precise mechanism was the cause. *See* Table 8 (Woodbury chart showing similar water levels). In order to determine the precise causes of failure, an expert would need to know the water level on the date of failure, construction details, condition, and observations prior to failure. Tr. 12587:11-12588:2 (Schaefer). Neither party had necessary evidence to adequately evaluate levee failure, so Mr.

Tofani assumed that any time the water levels were near (not above) the levee crest elevation, the levee overtopped by failure – without analyzing whether the failure was before or after the peak flow, or whether any distress caused slumping, distress, or otherwise contributed to failure before overtopping. He also failed to consider that seepage flooding would have occurred, and that upstream breaches caused flooding on Plaintiffs' land, regardless of and before any adjacent levee breach. *See e.g.* Tr. Mr. Tofani's conclusion that the Corps action caused these levee failures, and all resultant flooding, is speculative at best.

viii. Dr. Schaefer's and Dr. Mussetter's Methods to Analyze Erosion Are Reliable.

Plaintiffs Ideker, Blodgett Farms, Larson, and Hildebrandt claim portions of their property eroded, but the evidence does not support the claim that any erosion actually experienced was caused by the alleged actions of the Corps. To evaluate erosion claims, Dr. Schaefer and Dr. Mussetter compared the locations of Plaintiffs' erosion claims to notch locations, compared historical and recent aerial images, and then assessed the extent to the erosion. Tr. 12218:6 -19 (Schaefer), 10039:14-23. He concluded that post-2004 BSNP modifications were up or downstream significant distances (sometimes as many as two miles) and did not cause the erosion claimed.[96] Tr. 12416:24-12417:12, 1418:15-18, 12419:12-24, 12420:18-12422:6 (Schaefer), 10039:24-10040:21, 10042:12-20, DX3014-108. Furthermore, significant erosion occurred in 2011 at locations with and without BSNP habitat modifications. DX3018-388, -389, -392, and -393. *See* discussion *supra* § II.4.f.

e. Mr. Tofani's opinions lack necessary evidence

[96] For the Ideker property, the erosion was on another property upstream of the Ideker tract. Tr. 12418:15-18, 12419:3-24 (Schaefer).

Mr. Tofani's conclusion that all private and non-federal levees would have breached but for the Corps' actions alleged is not reliable because he lacks necessary data about the condition of the levees and date and water level of breaches. Mr. Tofani concludes that because the water levels during the 2011 flood were near or higher than most private and non-federal levees, they necessarily breached by overtopping, but he ignores the many other types of levee failures that can occur before, or even if, a levee overtops. Tr. 5854:19-5855:9 (Tofani). This conclusion rests entirely on the unreliable opinions of Dr. Christensen, which means his modeling of water levels at the time of the levee breach is not useful to reach any conclusions with respect to causation. *See Summit 6, LLC v. Samsung Elecs. Co.*, 802 F.3d 1283, 1299 (Fed. Cir. 2015) (To the extent an expert's "credibility, data, or factual assumptions have flaws, these flaws go to the weight of the evidence[.]"). Mr. Tofani also ignored testimony about factors that contributed to some of the non-federal and private levee breaches, such as a rodent hole causing the 2008 L&H Investments levee breach, and the levee district excavations and cut that contributed to a Holt 10 levee breach. Tr. 3630:18-3631:6 (Larson), 12677:18-12679:16 (Kneuvean), DX3016-65. Mr. Tofani relied on a few photographs that depict water overtopping some levees, and did not consider that other mechanisms, such as levee slump, can occur to damage a levee before water overtops it. He did no analysis of whether any such factors caused or contributed to levee failures in advance of the few where overtopping was documented. Without knowing the date of the breaches, or nature of any pre-overtopping distress, Mr. Tofani cannot reliably determine the cause of the breach. Furthermore, there are several levee failures where Dr. Christensen's estimated water levels do not rise above the levee crest, but Mr. Tofani nevertheless concludes with no basis that overtopping was the cause.[97] Tr. 5940:1-21 (Tofani), PX2883, PX2895,

[97] Mr. Tofani's analysis also presumes Dr. Christensen's water surface elevations are correct.

PX2898, PX2902, PX2913, PX2916 (depicting peak water levels below levee crest elevations). Even if Mr. Tofani's suppositions were reliable, his conclusion that all non-federal and private levees would not have overtopped absent the Corps changes relies entirely on Dr. Christensen's faulty conclusions and should not be credited.

f. Seepage and Groundwater Flooding Did Not Increase From Corps Actions Alleged

i. Dr. Schaefer's opinions result from the application of reliable methodologies to reliable data.

Dr. Schaefer used the same industry-tested method described for seepage modeling to quantify the differences in seepage amounts and groundwater levels and concluded that any changes due to alleged habitat actions, both increases and decreases, were minor, and that SWH chutes have not contributed to flooding on Plaintiffs' properties. Tr. 12218:24-12219:18 (Schaefer). Dr. Schaefer developed several steady-state seepage models, a practice widely accepted and validated by the geotechnical community, including the Corps of Engineers, to determine and compare seepage quantities likely to result from several alternatives. Tr. 12237:9-12238:15 (Schaefer). *See also* Tr. 11997:6-11 (Henggeler) (explaining that steady state analyses are done more frequently than transient analyses in part because they are more conservative and address the worst-case scenario).

ii. Dr. Schaefer's Methods are reliable.

After reviewing pertinent data and information, Dr. Schaefer selected property with a seepage claim in each region for modeling, and he selected numerous configurations to ensure that different conditions present along the river were evaluated. Tr. 12215:24-12216:10 (Schaefer). This was necessary because there was no actual measured seepage data for each site

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His own data shows that Dr. Christensen's elevations vary from GPS measured elevations by as much as 3 feet in some locations. Tr. 6192:10-6194:18 (Tofani), PX2553 (column titled "Mearsured Minus Estimated").

and modeling allowed for the comparison of seepage quantities at each site. Tr. 12216:20-12217:1 (Schaefer). For the properties that weren't modeled, information was extrapolated from the results of models of properties with similar characteristics. Tr. 12216:11-13 (Schaefer). After the models were complete, Dr. Schaefer evaluated the flood hydrographs produced by Riverside to determine the differences in water elevations under different scenarios and combine that with the seepage model results to determine how much seepage quantities would differ. Tr. 12216:14-19 (Schaefer).

iii. The Actions Alleged Have Not Resulted in Increased Seepage on Plaintiff Properties.

After conducting his analysis, Dr. Schaefer was able to determine that differences in seepage quantities between the baseline/actual scenario and the pre-2000 no-MMR scenario are minor. Tr. 12218:21-12219:18, 12302:22-12323:17 (Schaefer); DX3018-240. The attached Table 9 listing Dr. Schaefer's seepage results shows that minor differences in seepage were both positive and negative; in some instances, there was less seepage with the Corps changes. DX3018-240. Overall, the predicted seepage for the two scenarios is effectively the same. Dr. Schaefer also determined that no SWH chutes create the primary seepage entrance for any of the Plaintiffs' properties and have not contributed to the seepage flooding on the Plaintiffs' properties. Tr. 12219:13-15 (Schaefer). For the one property adjacent to a chute where seepage is claimed (Rouse), the chute was farther from the property than the river, the property was situated atop a former lake and poorly drained with low-lying areas, and the chute had no influence on seepage. Tr. 12288:7-22, 12287:10-12290:5, 12290:20-12293:21 (Schaefer); DX3018-225, DX3018-226, DX3018-228, DX3018-229. The other property adjacent to a chute (Cunningham Farms) has no claim for seepage; the chute is 1,800 feet from the property, and there are natural remnant channels between the chute and the property that form the primary

seepage entrances, so the chute does not affect seepage. Tr. 12285:7-12287:24 (Schaefer); DX3018-193, DX3018-195.

iv. Dr. Kopania's opinions result from the application of reliable methodologies to reliable data

Andrew Kopania, D. Env., an expert hydrogeologist with twenty-seven years of experience in the field, testified at trial about the groundwater flow and groundwater/surface water interaction during the alleged sixteen exfiltration flooding events.[98] Tr. 12773:15-12774:14 (Kopania). In Dr. Kopania's extensive practical experience as a professional hydrogeologist, he developed significant expertise in groundwater evaluation, modeling and analysis. Tr. 12773:17-12774:14 (Kopania); DX2084. He has done studies evaluating the relationship between groundwater levels, changes in rainfall, and surface creek flows, and between groundwater and agricultural properties, and has previously served as an expert witness in cases involving groundwater and surface water interaction and movement. Tr. 12775:18-12777:4 (Kopania); DX2084. Dr. Kopania has authored several publications and presented on groundwater topics as well. DX2084.

Dr. Kopania found no change in groundwater response resulting from the changes Plaintiffs allege, and that in the alleged exfiltration "flooding" incidents, where the water level did not even reach the toe of the levee or bank of the River, other factors such as heavy rainfall caused the flooding. Tr. 12778:22-12779:3, 12788:20-12790:5 (Kopania). Dr. Kopania also concluded that construction of SWH chutes did not cause higher groundwater surface elevations,

[98] In the sixteen exfiltration flooding instances Dr. Kopania studied, there was no overbank flooding alleged, but instead Plaintiffs alleged that water seeped up from the ground, either to prevent the planting of crops or otherwise cause water to stand on portions of their properties. These claims are as follows: George Neale Farm for 2007 and 2008; Adkins for 2007, 2008, and 2013; Husz for 2007, 2008, 2010, and 2014; Sieck for 2013; KMJ Farms for 2007 and 2013; Payne Valley Farms for 2007 and 2013; Griffin Farms for 2008; and Rouse for 2010. Tr. 12831:10-20 (Kopania); DX3019-85.

which is consistent with the findings in a 2006 USGS study. Tr. 1229. Dr. Kopania's opinions result from his analysis of the specific flood events alleged, the undisputed groundwater data reflecting groundwater flow toward – not from – the River, and a study of data showing heavy precipitation occurring concurrently with the alleged flooding events. Tr. 12789:15-21, 12861:9-12862:2 (Kopania). In many cases, these properties where exfiltration flooding is claimed are so far from the river that very minor changes to the water surface elevation for short periods of time would have negligible effects on the groundwater flowing from these properties to the river. Tr. 12831:10-12832:7, 12862:3-12864:21 (Kopania); DX3019-85.

v. Dr. Kopania's Method Was Reliable and Effective to Determine Causation.

Of the forty-four properties at issue, eight Plaintiffs assert seepage claims during years when the water did not come out of the banks of the river, or otherwise was below the toe of the levee. Tr. 12780:13-12781:10 (Kopania); DX3019-15. Dr. Hromadka asserts, in support of these claims, that groundwater elevations were higher as a result of changes to the Master Manual and MRRP projects, that higher groundwater levels following the 2011 flood contributed to later flood events as a result of a "memory effect," and that small changes in river levels result in larger changes to groundwater elevations. Tr. 5057:12-15, 5058:14-17, 5281:7-13, 5225:7-21 (Hromadka). In order to reach his conclusions negating Dr. Hromadka's opinions, Dr. Kopania first gathered and evaluated available groundwater and rainfall data as well as data about soil properties, and then analyzed the data in the context of Plaintiffs' claims. Tr. 12781:25-12783:12, 12794:19-24 (Kopania). Specifically, he used the data to determine the statistical relationship between groundwater levels and river levels during the alleged flooding, which is a standard methodology used by groundwater professionals, and appropriate for the data available. Tr. 12783:14-25, 12788:10-16 (Kopania).

vi. Dr. Kopania Relied on Relevant Data to Reach His Conclusions.

The data from four groundwater wells in Fremont, Monona, and Holt Counties provided the best evidence of the groundwater response because there were many data points during the period of the late 2000s when flooding is alleged. Tr. 12784:15-25, 12787:6-15 (Kopania). Although there were other wells in the region, they lacked the frequent and persistent groundwater measurements necessary to draw accurate conclusions about groundwater patterns. *Id.* As Dr. Kopania demonstrated, analysis relying on insufficient data points could lead to inaccurate conclusions. Tr. 12786:4-12787:15 (Kopania). Dr. Kopania also used well data from the alleged period of the flooding, rather than data from ten years earlier that Mr. Tofani used to reach his conclusions. Tr. 12811:1-13, 12814:7-18, 12816:10-25, 12823:4-21 (Kopania) (describing data from 2008 to 2014). The groundwater well results from the mid-1990s that Mr. Tofani used are not relevant to the question of whether groundwater was generally flowing toward or away from the river, and cannot reliably form the basis of conclusions regarding groundwater flow during the floods at issue. Tr. 12923:8-25, 12924:22-12928:3 (Kopania); PX2927, PX2928, etc.[99]

vii. The Corps Activity Alleged Did Not Change Groundwater Response, or Raise Groundwater Levels.

Dr. Kopania's analysis showed that during the period from 2007 to 2014, groundwater levels (and river levels) were generally lower than they were from 1995 to 1998. Tr. 12820:22-12823:2 (Kopania); DX3019-69, DX3019-70, DX3019-71. The data also showed that the groundwater level relative to the river elevation was similar during those two periods, so that the

[99] Exhibits PX2927 through PX2944 depict data collected from the 1990s, rather than during the alleged period of flooding. Mr. Tofani relied on this outdated and inapplicable data to reach an incorrect conclusion about the direction of groundwater flow during the exfiltration flooding events. Tr. 12830:9-19 (Kopania).

groundwater raised or lowered at between 81 and 90 percent of the change in river level elevation, at distances within several hundred feet of the river. Tr. 12811:1-10, 12812:21-12813:18, 12819:16-12820:11 (Kopania); DX3019-60, DX3019-64, DX3019-69. Generally, as the distance from the river increases, the change in groundwater elevation relative to the change in river levels is smaller, and there is a lag in time such that the groundwater does not respond immediately to river level changes. Thus, for a well 2,500 feet (approximately half a mile) from the river bank, the groundwater elevation change was only 62 percent of the river level change, and there was a seven-day lag in that response. Tr. 12817:20-12819:1 (Kopania); DX3019-68. The groundwater elevation data from a well 12,000 feet away showed little correlation with the river level, and far more correlation with rainfall. Tr. 12823:8-12826:1, 12825:19 (Kopania); DX3019-74, DX3019-75.

USGS groundwater data also indicated that between 2007 and 2014, the Missouri River[100] was a "gaining stream," meaning that groundwater elevations were higher inland, and flowed via gravity to areas of lower groundwater adjacent to the river whenever the water was below the river banks or levee toe. Tr. 12825:21-12826:4, 12811:1-13, 12813:19-24, 12818:17-12819:1 (Kopania); DX3019-60, DX3019-64. Because the river acted as a gaining stream during the exfiltration flooding events Dr. Kopania studied, the higher groundwater levels away from the river would prevent any flow away from the river toward the inland properties. Tr. 12796:4-13 (Kopania). Dr. Kopania also found high precipitation correlated from periods of claimed exfiltration flooding, whereas no claims of exfiltration flooding occurred when there were high river levels, even for longer duration, without accompanying high rainfall volumes. Tr. 12855:23-12856:2, 12857:1-11, 12868:25-12869:17 (Kopania).

[100] Dr. Kopania studied a 220-mile reach from River Mile 420 to 640, the stretch containing all 22 of the properties where seepage claims were asserted. Tr. 12784:3-5 (Kopania)

Upon application of the pertinent groundwater data during the periods of flooding, precipitation data, hydrology from Mr. Woodbury, and Plaintiff claims, Dr. Kopania found there was no basis to conclude that flood events and groundwater levels were higher for the sixteen exfiltration flooding claims than they would have been in the absence of the MMRs and channel changes. Tr. 12833:4-12834:3 (Kopania). For the very few exfiltration claims where Mr. Woodbury's worst case scenario predicted higher water levels with the Corps changes, the maximum river level change was less than one foot, so the effect on the groundwater levels would have been minimal, particularly given the distance between the Plaintiffs' properties and the river.[101] Tr. 12834:5-12835:7 (Kopania); DX3019-90, DX3019-18 (reporting distances from the river (or levee) between 1,200 and 7,500 feet for all claims with higher post-MMR water levels)..

viii. Shallow Water Habitat Projects Did Not Contribute to Seepage/Exfiltration Flooding.

Dr. Kopania's analysis and study of USGS data led him to conclude that because the river acted as a gaining stream, the shallow water habitat projects lowered the groundwater elevation at Plaintiffs' properties during exfiltration "flooding" events with the water below the river bank or levee toe. Tr. 12826:11-12827:3 (Kopania). The USGS data, and a report describing that data, from an MRRP project downstream of the plaintiff properties showed that chute construction lowered the groundwater elevation relative to the river for areas landward of the chute. Tr. 12827:4-12829:6 (Kopania); DX1229; DX3019-81.

Mr. Tofani's conclusion that shallow water habitats raise the groundwater level is

[101] There was one property with a higher Baseline/Actual water elevation than the No-MMR/Pre-2000 water level in 2010, and four properties in 2013. Property B-17 is 1,200 feet from the levee; B-18 is 5,300 feet from the river; B-20 is 5,300 feet from the levee; B-24 is 7,500 feet from the river; and B-25 was 3,000 feet from the levee during the 2013 flood. *See* DX3019-85.

incorrect because he relies on sporadic and inconsistent well data from 1995 to 1996 to wrongly conclude that the river was a losing stream, and ignored the opposite data from years of flooding. Opposite from Dr. Kopania, Mr. Tofani did not present any of the analysis and calculations on which his opinion is purportedly based, and because the data he used was not reliable, the conclusions should not be credited. Mr. Tofani also failed to quantify the magnitude of any purported increase in groundwater levels, or the specific properties, chutes, or years when any such increased allegedly contributed to flooding. Plaintiffs' vague and non-factual evidence with respect to groundwater levels and the influence of Corps projects on those levels is unreliable and cannot support a finding of causation for any Plaintiff properties.

g. None of Plaintiffs' experts analyzed quantities of seepage, and any general statements are not based on data or are refuted by the data and Plaintiffs' experts own analysis

Mr. Tofani did no quantification or analysis of seepage rates and locations, so he has no basis to conclude whether and what amounts of seepage would have occurred absent the Corps changes. Tr. 12241:23-12242:6 (Schaefer). He therefore cannot reliably refute the conclusions of Dr. Schaefer that there would have been similar amounts of seepage regardless of the Corps changes because of the duration and magnitude of flooding.

Dr. Hromadka's conclusion that minor changes in river level caused magnified change to groundwater levels, Tr. 5212:14-25, 5220:22-24 (Hromadka), is not supported by logic or data. In actuality, the groundwater level does not rise or fall more than the river level because drainage will allow pressure to equalize; the river and groundwater are not comparable to the closed barrel scenario Dr. Hromadka described where there is no drainage. Tr. 12330:14-12332:9 (Schaefer); Tr. 12871:10-12872:18 (Kopania); DX3018-251, DX3018-252. The groundwater well data Mr. Tofani presented also shows the same effect wherein the change in groundwater levels is always less than the change in river level because of energy losses. Tr. 12332:13-12333:1 (Schaefer);

Tr. 12872:5-17 (Kopania); DX3018-253. Dr. Hromadka's conclusion that persistent high groundwater from the 2011 flood contributed to later flooding also contradicts the undisputed data. The results of the limited groundwater modeling Dr. Hromadka performed, and the video he played at trial, show that when the groundwater level rises during a flood event, it comes back down afterward. Tr. 12327:5-12329:21 (Schaefer); Tr. 5597:21-5599:10 (Hromadka); DX3018-250. In each year following the 2011 flood, Dr. Hromadka's own graph shows groundwater levels returned to where they had been in early 2004, and in some cases to lower levels. *Id.*.

h. Plaintiffs' conclusions regarding an increase in the incidence of flooding are unreliable.

Mr. Tofani and Dr. Hromadka opine that there has been an increase in flooding since 2004 and 2007, but the bases for these and related opinions is only a compilation of Plaintiffs' reported memories of their properties flooding. Opinions based on such subjective, unreliable, and incomplete information (i.e. flawed data) should be afforded the same little, if any, weight lay witness memories themselves are given by courts. *See infra* Section III.17. *Summit 6, LLC v. Samsung Elecs. Co.*, 802 F.3d 1283, 1299 (Fed. Cir. 2015) (If an expert's "credibility, data, or factual assumptions have flaws, these flaws go to the weight of the evidence . . . ."); *Perreira v. Sec'y of Dep't of Health & Human Servs.*, 33 F.3d 1375, 1377, n.6 (Fed. Cir. 1994) ("An expert opinion is no better than the soundness of the reasons supporting it.").

i. Mr. Tofani's opinions merits no weight because the underlying assumptions and data are flawed.

Mr. Tofani's opinions rest on undisclosed and unverifiable data. To opine about an increased incidence of flooding, he created a chart splitting claimants above or below the Platte River, then plotted the number of reported "floods" each year, and compared the reported number of "floods" amounts to the peak flow rate of a single gage for each group. Tr. 6021:10-

25, 6241:25 (Tofani). Mr. Tofani testified that Plaintiffs' counsel and/or Dr. Hromadka gave him the underlying data, but he was unable to provide specifics regarding the source of the underlying data that was included. Tr. 6252:22-6253:21, 6266:4-18 (Tofani). The United States did not receive any list or spreadsheet with underlying data showing reported claims.[102] Mr. Tofani confirmed he did not rely on the materials the United States was provided. Tr. 6255:17-6265:23 (Tofani). The Court should give no weight to opinion testimony relying on undisclosed unverifiable data. *Rohm & Haas Co. v. Brotech Corp.*, 127 F.3d 1089, 1092 (Fed. Cir. 1997) ("Nothing in the rules or in our jurisprudence requires the fact finder to credit the unsupported assertions of an expert witness.").

ii. Flooding Is Not More Frequent After 2004 Just Because Plaintiffs Say So.

Despite Mr. Tofani's failure to disclose the source of his data, it is evident that his analysis rests upon when Plaintiffs told their attorneys flooding occurred before and after 2004. Plaintiffs' self-reported and self-serving claims, in whatever format provided, is unreliable and does not support Mr. Tofani's conclusions. Further, Mr. Tofani agreed that the accuracy of the underlying data "could be significant" to his analysis, but undertook no effort to verify the accuracy of that data. Tr. 6252:22-6253:21; 6267:18-6268:15 (Tofani). Though Mr. Tofani admits it is "beneficial to have as much information as possible, including knowledge of the source of the data," he knew little about the data he relied upon or its completeness and did not even calculate the totals reflected in his charts; Plaintiffs' counsel did. Tr. 6242:12- 6244:9,

[102] Plaintiffs failed to disclose these documents on numerous occasions: in their initial disclosures, during two years of written discovery, in their expert disclosures, and after the discovery violation was uncovered at trial. To date, the United States has still never been provided this source of information Mr. Tofani relied on at trial. *See* Def.'s Mot. to Strike Tofani Test., ECF No. 355. Mr. Tofani's analysis was disclosed only in his rebuttal report, so the United States' experts had no opportunity to refute it. *Id.* The United States has created two tables cataloging the information it did receive to show why Plaintiffs' self-reported information is unreliable. *See* Tables 10 and 11.

6246:3-5 (Tofani). He therefore could not explain whether an owner and renter making a claim for the same flood on the same property counted as one or two floods. Tr. 6245:16-21 (Tofani).

Mr. Tofani concedes his data is of limited value. He admitted that incomplete data could affect his results, and thinks it likely that there are missing flood events, including pre-2004 events. Tr. 6239:7-11, 6250:2-12 (Tofani). He also admitted his results "may be exaggerated" because of "people's tendency to remember more recent events more clearly" and "potential bias for people not to remember the older events." Tr. 6247:25-6248:6 (Tofani). In terms of other missing data, Mr. Tofani did not consider when a plaintiff acquired the property, and expected that the total incidents reported did not include flooding incidents prior to the time a landowner owned the property, which "could cause," and in some instances "probably did cause," exaggerated results compared to reality. Tr. 6244:16-20, 6245:4-11, 6247:25-6248:6 (Tofani). Mr. Tofani also admitted, and indeed logic requires, that if older events occurred but were not reported, the difference he reported for frequency of flooding incidents before and after 2004 would be reduced. Tr. 6240:13-20 (Tofani).

Additionally, Mr. Tofani failed to account for 1) the date Plaintiffs acquired their property, 2) whether non-representative Plaintiffs actually reported pre-2004 flooding at all, and 3) the fact that Plaintiffs presented vague and ill-defined descriptions of flooding. Mr. Tofani admits that Plaintiffs may not know about whether flooding occurred on the property when they did not own it. Tr. 6260:20-6261:9 (Tofani). Of the 44 representative properties, 15 were in the 2000s, 7 in the 1990s, and 6 in the 1980s, meaning they likely have limited or no prior knowledge of flooding before those times, except for the most extreme events (e.g. 1952); these recent acquisitions mean less pre-2004 floods were likely reported than occurred.[103] Tables 3-7

[103] *See, e.g.*, Tr. 3503:6-8 (Rouse does not know if there was seepage on the property prior to

at Column F. Among the narrative responses, the only insight into non-representative properties provided to the United States, only 48 of the 373 responses provided the date of acquisition; of those responses, more than 15 properties were definitively acquired after 2000, likely rendering Mr. Tofani's data on prior flood events incomplete and inaccurate.

Considering all 300+ Plaintiffs, Mr. Tofani's charts list only five total floods in the 1970s. PX2955, PX2952. However, the plaintiff narratives and trial testimony confirm that at least nine Plaintiffs flooded in the 1970s.[104] *See* Tables 3-7 at Column H (reflecting 1970s flooding at Hildebrandt, Sieck, Green, Buffalo Hollow, and Frakes properties). Even this number is likely low because 275 of the 373 claimants did not report **any** pre-2004 flooding (98 did). *See* Table 11.[105] Mr. Tofani admits that where the narratives did not address prior flooding, the property possibly experienced prior unreported flooding. Tr. 6259:5-6260:3 (Tofani).

It is also unclear whether plaintiffs defined flooding in the same way given vague and often dissimilar responses; Mr. Tofani does not know how vague responses were incorporated in counsel's counting, if at all.[106] *See* Table 11 (10 answers only vaguely responded about historic flooding). The fact that the representative Plaintiffs reported more years of claimed flooding as time passed after filing of the lawsuit strongly suggests that their understanding of what "flooding" meant changed over time. *See* Table 10 (showing more flood claims over time).[107]

2002); Tr. 3019:10-12 (Luce does not know if there was seepage on the property prior to 2002); Tr. 2048:12-22 (Barnes does not know if there was flooding on property prior to 2006).

[104] Non-bellwether Plaintiffs Lydick (#194), Neiss (#232), Cady (#38), Petit Farms, Inc. (#258), reported that their property flooded in the 1970s. DX2053 at 172, 203, 33, and 229.

[105] 69 of 373 narratives were missing. Table 11.

[106] *See, e.g.*, Tr. 6262:25-6264:20 (Tofani) (does not know how Holstine's reported seepage flooding in the early 1990s was incorporated into the data, if at all); Tr. 6263:21-6264:14 (Tofani) (does not know how Shuler's report of historic flooding every 12 years was incorporated into the data, if at all).

[107] As of Oct. 2014, Olson only asserted flooding in 2011, but by Mar. 2015 he added 2014, and by Dec. 2015 he added 2010. As of Mar. 2015, Shaner only asserted 2010, 2011, and 2014, but

iii. Mr. Tofani's Analysis Did Not Eliminate Weather As A Cause.

Mr. Tofani opined that weather can be dismissed as a cause of the alleged increase in flooding because "it's factored into the peak river flow rate." Tr. 6027:7-9 (Tofani). But, using only the peak yearly flow rate from a single river gage for both plaintiff groups does not fully account for weather.[108] Tr. 6022:1-8 (Tofani). Additionally, an annual peak flow measurement does not indicate when the peak occurred, the duration or source of the peak, or whether flows the remainder of the year were high, including if there were multiple flood periods.[109] Despite common sense and admitted limits to the use of an annual peak flow measurement, Mr. Tofani's analysis assumed that a single gage's measurement was sufficient though properties were hundreds of miles away from the gage. Such a measurement cannot do such heavy lifting.[110]

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by Dec. 2015, he added 2007 and 2008; As of Oct. 2014, Ettleman only asserted 2011, but by Mar. 2015 he added 2008 and 2010; As of Mar. 2015, Larson only asserted 2008, 2010, 2011, but by Dec. 2015 he added 2014 and 2015; As of Oct. 2014, Luce only asserted 2010 and 2011, but by Mar. 2015, he added 2007 and 2008.

[108] The peak flow from the gage at St. Joseph, MO (RM 450) was used for the entire lower 176-mile stretch of Plaintiffs below the Platte River. Tr. 6022:4-6, 17-22 (Tofani). The upper study area encompasses a 726-mile stretch of Plaintiffs above the Platte River.

[109] Mr. Tofani admits the annual peak flow measurement does not account for the duration of the peak nor antecedent soil conditions, which would affect the number of flood incidents that actually occurred. Tr. 6248:7-6250:3 (Tofani). *See, e.g.* Tr. 2345:13-17 (Schneider explained that even with a high river "[i]t takes a while" to flood, and he indicated that a high river for one day and three days is different); Tr. 1674:12-25 (Johnson explained that "any time you go past three or four days" with blocked drainage it can damage crops); Tr. 3009:22-3010:9 (Luce explained he experiences drainage issues when the river is at 18 or 19 feet "[i]f it's there long enough."). Further, Mr. Schneider's 2007 and 2014 flooding occurred at two different times in a month. *See, e.g.*, Tr. 2353:24-2354:1, 2333:12-15 (Schneider). Plus, if the river is high during times when crops are not planted, landowners may not notice, and certainly are not likely to recall such high-water events decades later because no crops are affected. *See, e.g.*, ECF No. 257-9 (St. Joseph peak flow occurred in September in 1989 (p. 838), and March in 1978 (p. 792) and 1979 (p. 796); *Cf.* Tr. 1674:12-21 (Johnson explained the blocked drainage caused damage in 2007 because it occurred during a critical period for the crop).

[110] This flawed assumption also contradicts credible expert testimony about considering local and regional precipitation near every property in the reach. Tr. 10804:3-10806:7 (Woodbury).

iv. Dr. Hromadka's opinion that flooding increased after 2007 merits no weight because the underlying assumptions and data are flawed.

Dr. Hromadka opines that there was a "[m]arked uptick in incidents starting in year 2007" that indicate a "change" in the river. Tr. 5086:9-5087:17. (Hromadka). He claims he is "able to show the marked increase in flooding incidents by plotting, versus year, the number of claims." Tr. 5480:18-21 (Hromadka). Dr. Hromadka's opinions, again, are based only on a compilation of plaintiffs' own suppositions that flooding has increased.[111] Tr. 12333:3-10 (Schaefer). Dr. Hromadka developed an incident chart "[b]ased on eyewitness reports from property owners," as documented in depositions, interrogatories, and interviews. Tr. 5233:11-12; 8493:23-24 (Hromadka). No analysis or confirmation of the memories occurred, and "anybody in th[e] courtroom" could have "create[d] the same chart [he] did" because it simply "represents what was said." Tr. 8491:21-8493:5, 8499:23-24 (Hromadka). If Plaintiffs did not remember or otherwise report an incident, it is tabulated as if no incident occurred.[112] Tr. 8493:11-13; 8495:24–8496:4, 8497:8-16 (Hromadka). This tabulation of eyewitness accounts lacks a meaningful comparison of similar flood events. Tr. 12333:11-12334:15 (Schaefer) (describing how witness memories of flooding were uncertain, and non-specific). Several plaintiffs even testified about prior flooding that is not reflected on Dr. Hromadka's incident chart.[113] Dr. Hromadka agreed that it is common sense that people are more likely to remember

[111] Unreliable eyewitness memories played a large role in Dr. Hromadka's analysis generally. Dr. Hromadka explained that "[e]witness accounts were critical" to his analysis, "the foundation of the evidence," and that it "all comes back to the eyewitnesses." Tr. 5222:19-22 (Hromadka). Dr. Hromadka's "main" basis for concluding the operations of the reservoirs caused the flooding "was the eyewitness accounts." Tr. 5603:3-12 (Hromadka). Such opinions merit little weight.

[112] Dr. Hromadka also relied on data plotting reported incidents of flooding back to 1967 provided to him from Plaintiffs' counsel. Tr. 8519:12-21; Tr. 5077:3-4, 19-20 (Hromadka).

[113] *Compare* PX2006 *with* the flood events missing from the chart: Tr. 465:11-12 (Andersen's 1997 flooding on property 4A), Tr. 1231:1-9, 1233:15-17 (Brainard's 1993, 1996 and 2003 flooding), Tr. 588:2-5 (Salter's "more than two" floods in 1990s), Tr. 1649:20-24 (Roth's 1995

recent events as opposed to past events, more likely to remember the first time something significant occurs, and more likely to remember certain types of flooding, including floods that created more inconvenience.[114] Tr. 8495:24-8496:4, 8512:13-17, 8514:4-8515:3 (Hromadka). Several Plaintiffs admitted they did not thoroughly investigate the complete history of prior flooding, though they often had to check crop insurance or other records to determine when even post-2004 flooding occurred.[115] Further, Dr. Hromadka admits that the data he relies upon to support his analysis is subjective in regard to what constitutes an incident, in that only incidents that “exceed the property owner’s tolerance” for inconvenience are reported.[116] Tr. 5063:3-25; 8491:7-12; 8492:12-14 (Hromadka). Finally, Dr. Hromadka did not think it was important to consider when the Plaintiffs acquired their property, though many did not own the property for the entire analysis period. Tr. 8508:2-8509:9 (Hromadka); Tables 3-7 at Column F (showing that 15 of the representative Plaintiffs did not own their property until at least the 2000s).

i. The Court Should Not Rely on Plaintiffs’ Expert Conclusions.

Dr. Christensen’s methodology and reasoning is flawed because, among the many other errors described above, he assumed that any variance from averages is a change

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flooding on property 281), Tr. 1674:4 (KMJ Farms’ recognition that there would have been seepage in 1993), Tr. 2880:13-22 (Griffin’s 1999 flooding).

[114] Dr. Hromadka also agreed that that people’s memories can be influenced when they are part of a group that believes they have been subject to the same events, and motivated to not remember things in the past if it is to their advantage. Tr. 8497:12-22 (Hromadka).

[115] *See, e.g.*, Tr. 2356:12-22 (Schneider needed gage data to remember recent flooding, and did not check records before 2007); Tr. 2550:5-10 (Garst relied on notes for details of recent flooding, but did not check books prior to 2007); Tr. 3412:19-3413:8 (Cunningham heard about flooding in 1952, but did not ask about flooding before he bought the property in 1976); Tr. 1088: 5-15 (Sieck didn’t know which year flooded until checking his records just before trial).

[116] The bias inherent in this information is evidenced in Table 10, wherein many plaintiffs added post-2004 flooding year claims as the case progressed, indicating that unreported “tolerable” incidents at the time the case was filed became “intolerable’ only once plaintiffs had a stake in reporting more flooding. Table 10 (Evolution of Post-2004 Flooding Claims).

attributable to the Corps, and he failed to consider whether differences in geometry or factors other than Corps changes could have resulted in the disparate water levels. This error is fatal to his analysis because of the documented effects on water levels from increases in levee heights well before 1993, and because levees continued to be raised after 1993 and even after the flooding alleged here. *See* discussion *supra* § II.14.d. Dr. Christensen also improperly modeled releases under the 1979 manual, replacing his judgment of flood control with that of experienced operators, and disregarding effects of changes in releases to other authorized purposes. His analysis reflected hindsight not applicable to real-time release decisions. *Id.*

Dr. Hromadka's speculative conclusions regarding flooding and erosion lack calculations, quantification, or data are thus are insufficient to show causation. Dr. Hromadka asserts that MRRP projects caused sedimentation of the channel, but the data show as much degradation as aggradation, and he failed to quantify the aggradation within 5-feet increments, and did no analysis to isolate naturally-occurring aggradation from that attributable to the Corps. *See* discussion *supra* § II.4.e. He and Mr. Tofani opined that flooding is more frequent in the past, but their analysis relied entirely on self-serving reports of flooding from the plaintiffs, whose testimony indicates and reason suggests they are not reliable reporters. *See* discussion *supra* § III.20.i.

Mr. Tofani's conclusions about levee breaches rely on Dr. Christensen's simulated water surface elevations that are inaccurate, so they are similarly unreliable. He also relies on untrustworthy and biased eyewitness accounts to speculate about what formed the scour hole, and provides no analysis explaining what hydraulic processes the chute purportedly changed. None of Plaintiffs' experts reliably show there has been an increase in the incidence, severity, or duration of flooding.

21. Application of Analysis of Each Legal Topic, Including Expert Opinions, to Each Plaintiff

Neither the factual data, nor Plaintiffs' expert analysis demonstrates that flooding would not have occurred but for the actions alleged, or that any incremental flooding attributable to Corps actions was significant in severity or duration. Tr. 4489:8-4490:1 (Christensen) (admitting that some flooding would have occurred regardless).

a. The Undisputed Facts Do Not Support Plaintiffs' Allegations.

Plaintiffs' properties have always been subject to high flood risk, and the character of recent flooding imposed no new burden of flooding that would not have existed absent the Corps changes. See discussion *supra* § II.16. To the extent Plaintiffs knew about the flood history, Plaintiffs admitted that every property flooded prior to 2004; some of them many times. *See* Tables 3-7 at Column H. All but three of the properties lie within designated flood hazard zones, and some within the FEMA designated floodway. *Id.* at Column E. Many of the Plaintiffs' properties are situated in low-lying areas designated as ponding areas behind levees, areas that were formerly lakes, or otherwise overlie historic river channels. *See* Tables 3-7 at Columns N and O; *see also* discussion *supra* §§ II.14.a.ii and III.20.g.iii, DX1122. Some properties are in areas of the River with naturally low channel capacities such that flows frequently overtop the river bank. *See* discussion *supra* § II.16. Thus, Plaintiffs' land is by its nature subject to flooding from multiple factors that influence the magnitude and duration of flows.

The evidence indicates that the post-2004 flooding was not unprecedented, as Plaintiffs claim. Recurrent flooding within multi-year periods is not unique within the Missouri River Basin, which is typified by wet and dry cycles. *See* discussion *supra* § II.1; DX975. The 1952 flood was so severe that though many plaintiffs did not experience it, they

have heard about the severity and damage, or otherwise seen pictures or high-water marks. *See e.g.* Tr. 73:21-22 (Tobin) (describing how the 2011 flood replicated the 1952 flood), 1038:7-1039:2 (Sieck), 1290:16-18 (Jackson). Flow rates were higher in 1952; in 1993, stages were higher in some places and numerous federal levees that did not overtop in 2011 did in 1993. Tr. 3902:19-22 (Frakes), 8726:11-22 (Shumate), DX3005-67. *See also* DX1171-0020 (describing the severity of the 1952 and other floods). For many Plaintiffs, past floods had higher water levels. As an example, the floods of 1984 and 1996 were of a greater magnitude on some representative properties than flooding in 2007, 2008, 2013, and 2014.[117] Groundwater levels were not higher than levels in the past. Tr. 12819:6-12822:6; 12845:25-12847:8; 12848:25-12849:9 (Kopania). Plaintiffs' claims of unprecedented recent flooding are not supported by data.

Nor have Plaintiffs shown that flooding since 2004 has changed the character of Plaintiffs' land in a manner necessary to support a taking claim. *See Danforth v. United States*, 308 U.S. 271, 286-287 (1939) (rejecting a claim because the additional floodwaters did not create "a burden, actually experienced, of caring for floods greater than it bore" before). *Compare Ark. Game and Fish*, 736 F.3d at 1371 (describing how the flooding "changed the character of" the property and interfered with the plaintiff's "ability to use the property in the manner it had been used for many years.") Plaintiffs have been able to farm

[117] For the Adkins property, peak elevations at the nearest gage were above 29 feet in 1984 and 1996, and below 27 feet in 2007, 2008, 2013, and 2014. DX2032. For Husz, stages during the 1984 flood exceeded those in 2007, 2008, and 2014. *Id*. For Sargent, the 1984 and 1996 floods were of greater magnitude than the 2008, 2010, and 2014 floods. DX2031. For Ettleman, the 1984 flood stage was greater than 2008 stages. DX2019A. For Griffin, 1984 stages exceeded the 2008 stage. DX2034. For Buffalo Hollow Farms, stages were higher in 1973 and 1984 than in 2007, 2008, and 2014. DX2035. For Hildebrant, stages in 1979 and 1984 were higher than in 2007 and 2008. DX2035. For Ideker, flood stage in 1967 and 1984 exceeded those in 2014. DX2034. For Schemmel, the 1996 flood stage exceeded that in 2014. DX2033.

and harvest their properties in years following the flooding, and there is no evidence this farming cannot continue in the future. *See* Tables 3-7 at Column I.

The timing and volume of precipitation from 2007 to 2014 was well above average, with precipitation at varying locations within the top ten ever on record, so the fact that flood-prone properties flooded is neither remarkable nor unprecedented.[118] *See* discussion *supra* § II.15. The high-volume flows were mostly concentrated in areas downstream of the mainstem dams, which is consistent with weather trends. *See* discussion *supra* § II.15. The Corps plainly did not cause this above-average precipitation, and Plaintiffs provide no evidence that precipitation events similar in timing and magnitude to those here would not have caused the same flooding but for the Corps' actions 2004.

b. <u>Minor Increases in Water Levels Do Not Equate to Increased Severity of Flooding.</u>

The United States' experts have shown that the challenged species changes had little effect on water surface elevations during the flooding, and did not increase the severity or duration of flooding on Plaintiff properties. The attached Table 8, lists Mr. Woodbury's conclusions with respect to differences in water surface elevations and duration of high water, compared to pre-2000 channel geometry (grey columns), post-2004 channel geometry without channel changes (red columns), and reflecting operations under the 1979 Manual without any discretion (green columns).[119] Table 9 summarizes Dr. Schaefer's conclusions about amounts of seepage for the 22 properties where Plaintiffs claim seepage related

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[118] Interior drainage problems occur when levee catchment basins, typically designed only for a 10-year precipitation event, cannot drain. *See* discussion *supra* § II.14.a.ii.

[119] The grey line reflects the most conservative analysis wherein any post-2000 channel changes are deemed a change attributable to the Corps. This is conservative because Dr. Mussetter demonstrated the natural aggradation during the low-flow periods of the early 2000s. The red line reflects an analysis closer to reality where projects are removed, and the channel geometry is updated depending on the year of analysis.

flooding. Even assuming that an amount of the property intrusion was attributable to the government action, that amount and its consequences were not greater in severity and duration compared to the existing intrusion.

There are no instances when flooding would not have occurred absent the Corps' actions. For all 44 properties in every year of flooding alleged, the most conservative analysis shows that under the 1979 manual and pre-2000 channel geometries, flooding would still have occurred. *Compare* Table 8 at Columnn I and B. As set forth more fully below, where Mr. Woodbury's water surface elevations show increased water, it is miniscule compared to the extensive flooding that would have occurred regardless. Under these circumstances, there is no taking. *See Alost*, 73 Fed. Cl. at 494 (comparing amount of intrusion attributable to other causes); *Danforth*, 308 U.S. at 286-287. Furthermore, the low-lying flood-prone nature of Plaintiffs' properties indicates that the flooding, and any minor increases thereto, were "within a range that the property owner could have reasonably expected to experience in the natural course of things[,]" *Id. See also Nat'l By-Products, Inc. v. United States*, 405 F.2d 1256, 1274 (Ct. Cl. 1969). Even a significant incremental effect due to government intrusion is inconsequential when it occurs "in connection with a truly major flood event." *Leeth*, 22 Cl. Ct. at 487. Here, Plaintiffs have failed to show that Corps actions caused more than a minor incremental effect, and have failed to show that those actions increased the severity or duration of flooding so as to change the character of Plaintiffs' land. *Ark. Game & Fish*, 736 F.3d at 1371.

c. Water Levels Differences Were Not Significant.

For each of the years discussed below, only a small magnitude of any increases in water levels or duration, if any, was attributable to Corps actions, and those actions were only

a secondary contributor, if at all, to the flooding.

In 2007, severe rainfall in the Dakotas and downstream caused flooding at 17 representative properties. Floodwaters in 2007 reached the ninth highest stage recorded at the Omaha gage since 1978, tenth highest at Nebraska City, and fourth highest at Rulo; peak flows were the fifth highest rate at Rulo. Tr. 8849:11-12 (Shumate), DX2032 at 321; DX2019A at 231; DX2034 at 236, DX0970-0021. The few properties behind non-federal or private levees that overtopped or breached (Holt 10, Hildebrandt, Green) are situated in areas where the Corps has been documenting increasing flood stages attributable to non-federal and private levee construction for decades.[120] *See* discussion *supra* § II.14.d (describing areas south of RM498 and Holt County as being affected by increasing flood stages). There were no claims where water levels would have been more than half a foot higher than - water levels under the No-MMR, No-SWH scenario. *See* Table 8 at Column A. Thus, there was no increase in severity or duration of flooding. *See e.g.* Table 8 at Column A (indicating that there were no claims where water levels would have been more than half a foot higher than water levels under the No-MMR, No-SWH scenario.).

In 2008, severe rainfall in Iowa, Nebraska, and Missouri caused flooding alleged at 23 representative properties.[121] Floodwaters reached the eighth highest stage since 1978 at Omaha, sixth highest at Nebraska City, and fifth highest at Rulo gage. Tr. 8849:15-16 (Shumate), DX2032 at 330; DX2019A at 239; DX2034 at 244, DX3005-67. Mr.

[120] This same conclusion applies for the properties behind levees that overtopped or breached in 2008 (Hildebrandt, L&H Investments, and Frakes), 2010 (Hildebrandt, Sargent, Ideker, Drewes, Cunningham, Binder, Sargent, L&H Investments, Ideker, and Frakes), and 2011 (Ettleman, KMJ Farms, Payne Valley, Woltemath, Barnes, Garst, Griffin, Ideker, Green, Luce, Buffalo Hollow, Frakes, Hildebrandt), including even the federal levees where 1980s studies reflected lower levee capacities. *See* discussion *supra* § II.14.d.

[121] One of the 2008 claims was not timely disclosed, so was not analyzed by Mr. Woodbury. The United States is separately moving to dismiss this 2008 claim by Plaintiff Sieck.

Woodbury's analysis showed only one claim where water levels would have been more than 0.5 feet higher than water levels under the No-MMR, No-SWH scenario. *See* Table 8 at Column A. For the one instance where water levels were more than half a foot higher (but less than one foot) without the Corps activity, the flooding was already so severe that the minimal increases did not increase the severity or duration of flooding. *See e.g.* Table 8 at Column I (indicating that water elevations at the Salter property were still below the overbank elevation).

In 2010, the severe flooding caused by rain in Iowa and the Dakotas caused flooding at 31 representative properties. Floodwaters reached the fifth highest stage since 1978 at the Omaha gage, third highest at Nebraska City, and second highest at Rulo; peak flow was the sixth highest at Rulo. Tr. 8849:13-14 (Shumate), DX2032 at 347; DX2019A at 255; DX2034-0260; DX3005-67, DX0970-0021. Mr. Woodbury's analysis showed no claims where water levels would have been more than one foot higher than water levels under the No-MMR, No-SWH scenario. *See* Table 8 at Column A. For those four instances where water levels were more than half a foot higher (but less than one foot) without the Corps activity, the flooding was already so severe that the minimal increases did not increase the severity or duration of flooding. *See* Table 8 at Column A (indicating that Ideker would have still flooded 5.3 feet over overbank or 10.3 feet over his drainage; and Buffalo Hollow 10 feet over his drainage); *see also* Table 9 as Column E (indicating that Luce experience no additional seepage due to Corps activity; Green experienced only five percent more seepage; and Buffalo Hollow Farms experienced three percent less seepage).

In 2011, flooding from extreme runoff and precipitation in the upper basin overwhelmed the basin and the water levels and duration were so extreme that the

independent panel report assessing the flood found a 500-year flood was likely the best estimate of the recurrence frequency. Tr. 13704:9-25 (Grigg). The flooding far exceeded the duration of all prior events within the Omaha District. Tr. 9353:17-9354:1, 9355:6-16 (Pridal). Floodwaters reached the highest stages recorded at the Omaha, Nebraska City, and Rulo gages. Tr. 8849:6-10 (Shumate), DX0970-0021, DX2032 at 354; DX2019A at 263; DX2034 at 268. Floodwaters on Plaintiffs' properties ranged up to fifteen feet above the overbank elevations or the levee toe. *See* Table 8 at Column I. All 44 representative properties flooded.

Mr. Woodbury's analysis showed there is only one claim where water levels would have been more than one foot higher than water levels under the No-MMR, No-SWH scenario. *See* Table 8 at Column A (indicating water levels for Plaintiff Rouse). Mr. Woodbury's analysis showed that he would have still flooded for 153 days under the No-MMR, No-SWH scenario, and Dr. Schaefer's analysis showed a negligible difference in seepage quantities as seepage from the chute affects the property less than seepage from the main channel. *See* Table 9 at Column E. There were no instances where water levels were more than half a foot higher (but less than one foot) without the Corps activity. *Id*.

In 2013, severe rainfall in Iowa and upstream caused flooding alleged at 11 representative properties. Mr. Woodbury's analysis showed no claims where water levels would have been more than one foot higher than water levels under the No-MMR, No-SWH scenario. *See* Table 8 at Column A. For those four instances where water levels were more than half a foot higher without the Corps activity, the flooding was already so severe that the minimal increases did not increase the severity or duration of flooding. *See e.g.* Table 8 at Columns I and J (indicating that Jackson would have still flooded with 0.6 foot of water over

his overbank, Salter with 0.9 feet over his overbank, Larson with 1.2 feet over his overbank; Adkins with 1.3 feet over his drainage, and Ideker with 4.5 feet over his drainage)..

In 2014, extreme precipitation in the Dakotas and elsewhere caused flooding at 12 representative properties. Since 1978, the floodwaters were the sixth highest stage at the Omaha gage and the eighth highest at Nebraska City. DX2032 at 377; DX2019A at 286. There was only one claim where Mr. Woodbury's conservative estimate of maximum possible difference due to Corps changes was greater than one foot (Olson 2014). *See* Table 8, Summary of Woodbury Analysis. In that instance of claimed overbank flooding, the water was only above the overbank elevation for 3 days total, and water levels higher for one day longer. *Id.* Mr. Woodbury's analysis showed there are no claims where water levels would have been more than a tenth of a foot higher than water levels under the No-MMR, No-SWH scenario. *See* Table 8 at Column A (indicating that there is no claim where water levels would have increased under the No-MMR, No-SWH scenario; and only once claim under the pre-2000 No-MMR, No-SWH scenario would have been 0.1 feet higher (i.e., Ideker).

22. The Alleged Flooding Was Not the Direct, Natural and Probable Cause of the Corps' Actions.

Even if Plaintiffs were able to meet their burden to show that Corps actions caused flooding that would not otherwise have occurred, the flooding they described was incidental or consequential to those actions and was not the direct, natural or probable result of modifications to the Manual and construction of habitat projects. Plaintiffs seemingly rely on claims by landowners with respect to the Master Manual revision theorizing that interior drainage problems were a *possible* result of the spring pulse, but offer no proof that increased flooding was a *probable* (or an *actual*) result. Accordingly, they cannot meet the test for liability set out in *Moden*. *See* 404 F.3d 1335. After the Corps was alerted to a *possibility* that interior drainage

could be impacted by the then-contemplated spring rise, it studied potential impacts to drainage then ultimately reduced the duration and lowered the magnitude to a spring pulse, and did not relax flood-control constraints, in order to reduce flood risk. *See* discussion *supra* § II.8. Plaintiffs concede no flooding occurred during spring pulses, but argue that flooding was the probable result of Master Manual changes based solely on landowner concerns regarding the pulses. Tr. 13066:19-13070:16 (Cieslik), 3924:7-3925:23 (Frakes). Comments on mitigation projects proposed concerned loss of tax revenue, not flooding. *See* discussion *supra* § II.5.

Numerous experienced professional engineers described how projects were designed to avoid adverse impacts to water surfaces, which was confirmed by hydraulic analyses. *See* discussion *supra* § II.10. With respect to MRRP construction, Plaintiffs can point to only one pre-construction analysis that indicated further study was needed because of a potential for increased water levels; the later more-detailed study confirmed no such increase. Tr. 9278:7-23, 9281:21-9282:24, 9284:23-9285:7 (Pridal), DX1016, DX1106. In-channel projects such as dike notches and structure lowering were done to halt increases in flood elevations precipitated by floodplain accretion after 1950s and later documentation of flood stage increases attributable to BSNP construction. *See* discussion *supra* § II.3.b and II.10.a.. Plaintiffs now baselessly allege that the same structure modifications and notches, when done after 2004, suddenly resulted in the exact opposite effect than decades earlier. Plaintiffs' argument defies reason and lacks evidence. For ESH where no new sediment was added, no probably adverse flood effects were identified. As professional engineers Mike Chapman, Chance Bitner, John Remus and Dan Pridal testified, based on their engineering judgement and experience concerning the design and construction of MRRP projects, flooding was not a likely effect of the projects. Indeed, their judgment was confirmed by post-construction seepage and sedimentation analyses that have detected no

adverse effects from project construction because of mitigation measures constructed and because the river's sediment transport capacity far outweighs the minor sediment projects add.

Plaintiffs cannot prove that the Manual revisions and MRRP projects set in motion a sequence of events making future flooding more probable, or increased the risk of a detrimental result, as needed to show the flooding was the direct, natural, or probable result of government action. *Cary*, 552 F.3d at 1378. As in *Nicholson*, there is no indication that the overwhelming rainfall that occurred in each year of flooding "was a condition initially set in motion by the" modifications to the Manual or any other changes alleged. 77 Fed. Cl. at 618. *See e.g. Cary*, 552 F.3d at 1378. Nor did the Corps actions initiate "'a succession of events … which, when the events had all occurred in their natural order,'" cause plaintiffs' properties to flood when they would not have otherwise. *Id.* (citing *Cotton Land*, 75 F. Supp. 232). The excess rainfall and runoff in each year of flooding, described by Mr. Hudson, Mr. Woodbury, Ms. McCarthy and others here altered the natural order and means that the flooding is not the natural, probable, result of the government action. *See e.g.*, *Bartz*, 633 F.2d at 577; *National By-Products, Inc. v. United States*, 405 F.2d 1256, 1274 (Ct. Cl. 1969 (describing weather as "severe"). As with the facts in *Baird*, the flooding here was caused by "unusual climatic conditions" and were no more than "'a random event induced more by a natural phenomenon than by Government interference' for which there can be no taking." *Baird v. United States*, 5 Cl. Ct. 324, 330 (1984) (internal citations omitted). Other non-government acts such as levee relocation and levee raising have similarly changed the topography near plaintiffs' properties, and likely in myriad other places within the 800-mile reach, and any effects therefrom cannot be deemed the natural result of the Corps actions alleged. *See e.g. National By-Products*, 405 F.2d at 1274 (describing how the creek had always been subject to flooding from which the plaintiff was spared only because of

nearby levees breaching that lowered water levels). Plaintiffs cannot meet their burden to show any increased flooding was the natural, probable, result of Corps actions alleged.

The distance between plaintiff properties and both the reservoirs and habitat projects also demonstrates how the flooding alleged was not the natural probable result of the changes alleged. *See Moden*, 60 Fed. Cl. at 289 (considering the 5-mile distance from the alleged contamination and drainage features on the property). In contrast with the scenario where a party knows that dam construction will permanently back up water upstream, or where a party knows that yearly purposeful high releases will affect downstream waters, the Corps' changes to the Manual were neither intended nor believed likely to decrease flood control benefits of the dams when severe precipitation might occur – as it did here. *See e.g. United States v. Dickinson,* 331 U.S. 745 (1947) (holding that taking occurred where dam caused water level to rise and inundate abutting property); *Pashley v. United States*, 140 Ct. Cl. 535 (1957) (holding government liable for taking property one mile below dam, where previously dry land became inundated to a depth of 42 feet). These far-downstream landowners in disparate locations with varying topographies and levels of self-constructed protection are necessarily impacted from varying flows in the River, whether originating from upstream precipitation, tributaries, or dam releases. The law does not and should not assign liability whenever any change in dam operations corresponds in unfortunate ways with weather, especially where, as here, the Corps could not foresee how any result of its changes would affect each downstream landowner for hundreds of miles based on how much and when rain falls in a given year. With respect to habitat construction, Plaintiffs' experts cannot even correlate any physical effect of habitat project construction to specific locations or plaintiff properties, so their argument that the Corps set in motion a sequence of events making flooding miles away probable strains credulity. As logic and the calculations of

Dr. Mussetter, Mr. Woodbury, and Corps engineers showed, any effects on water levels from project construction are minor and localized. *See* discussion *supra* § III.20.a.iv. The evidence shows that if anything, multiple constructed projects in an area lower, rather than raise stages. Tr. 9635:9-11, 9636:20-9638:20 (Bitner), DX1205, DX228, DX229. Plaintiffs have not met their burden to show that any flooding that Corps actions actually caused was the natural probable result of the Master Manual revisions or the MRRP projects.

IV. CONCLUSION

The United States asks that the Court grant judgment in its favor for each of the Plaintiff claims because the evidence does not show that any of the changes alleged has caused or contributed to the severity or duration of flooding beyond what would have been experienced absent the Manual changes and habitat construction.

Respectfully submitted this 21st day of September, 2017.